WRD
WATER REPLENISHMENT DISTRICT
OF SOUTHERN CALIFORNIA

1959 WATER REPLENISHMENT DISTRICT 50 ANNIVERSARY 2009

November 17, 2010

United States Environmental Protection Agency, Region 9
75 Hawthorne Street (SFD-7-1)
San Francisco, CA 94105

Attn: Ms. Lynda Deschambault, Remedial Project Manager

Subject: WRD Comments on Proposed Plan for OU-2 Groundwater Contamination Omega Chemical Superfund Site, Whittier, California

Dear Ms. Deschambault:

The Water Replenishment District of Southern California (WRD) appreciates this opportunity to submit our comments to the United States Environmental Protection Agency (USEPA) regarding the proposed cleanup plans for the Operable Unit 2 (OU-2) groundwater contamination at the Omega Chemical Superfund Site (Omega site), which is located in the City of Whittier, California. As you know, WRD manages groundwater replenishment and groundwater quality within the Central Basin which the Omega site overlies, and as such, has a strong interest in protecting the groundwater resources for the water purveyors and the public in the area. WRD has been working closely with the USEPA for years to help them expedite the Omega site investigation and to provide support in any way possible through data sharing, facilitation of local meetings, education to the USEPA on the intricacies of groundwater pumping in the adjudicated Central Basin including pumping rights, water purveyors, replenishment assessments, replenishment operations, and clarification of Watermaster and WRD duties, and retaining the United States Geological Survey (USGS) to perform a regional assessment of aquifer vulnerabilities in the vicinity of the Omega site plume.

WRD looks forward to the rapid implementation of an interim remediation plan by USEPA that adequately halts the further spread of contamination to down-gradient users in the Central Basin, and to the development of an ultimate plan to provide full-scale containment and remediation of the entire Omega contamination plume. Below are our General and Specific Comments related to the USEPA's proposed remediation plan. To assist WRD in preparing for our comments, we retained the consulting firm of WorleyParsons to evaluate the data presented in the following USEPA documents:

a) Remedial Investigation/Feasibility Study Reports, Omega Chemical Corporation Superfund Site, Operable Unit 2, Volume 1, by CH2M Hill for USEPA, August 2010. (RI Report)

4040 Paramount Boulevard
Lakewood, CA 90712
Tel (562) 921-5521
Fax (562) 921-6101
www.wrd.org

b) Final Feasibility Study Report, Omega Chemical Corporation Superfund Site, Operable Unit 2, Whittier, California, by CH2M Hill for USEPA, August 2010. (FS Report)

c) Proposed Plan for OU-2 Groundwater Contamination, Omega Chemical Corporation Superfund Site, by USEPA, August 2010. (Proposed Plan)

WorleyParsons summarized their evaluation results in a Technical Memorandum (Tech Memo), which is enclosed with this letter as Attachment A. WRD utilized this Tech Memo as a basis for our comments and agree with the Tech Memo's findings and recommendations. In addition to WRD's summary comments below, WRD requests responses from USEPA to the detailed information presented in Attachment A.

GENERAL COMMENTS

WRD strongly supports USEPA's Remedial Action Objective to "decrease lateral and vertical spreading of COCs [contaminants of concern] in groundwater at OU-2 to protect current and future uses of groundwater." Additionally, WRD supports the interim remedial alternatives presented in the Proposed Plan where plume-wide extraction and remediation will be conducted with the various beneficial end uses, with the exception of using the treated water for spreading basin recharge (Alternative #5). As discussed in the Proposed Plan, Alternative #5 should not be considered because delivering the treated water to the spreading basins could interfere with current replenishment operations at the spreading basins and will not allow continuous pumping from the proposed remediation extraction wells, since the spreading basins require extended shutdowns for routine maintenance activities. Regarding the final selected remedial alternative for the OU-2 plume, our comments are based on the assumption that USEPA will ensure that the treated water will meet all of the water quality standards applicable to the final selected end use of the treated water. For example, if drinking water end use is the selected alternative, WRD is assuming that USEPA will work closely with the California Department of Public Health to ensure the treated water is safe for public consumption.

USEPA's interim remediation plan is predicated on the belief that the OU-2 plume has impacted shallow groundwater (i.e., the upper 200 feet). However, strong evidence suggests (see Attachment A) that the OU-2 plume has impacted deeper groundwater which could be a larger threat to drinking water wells than a shallow plume. The interim plan should be amended to not only provide shallow plume containment at its leading edge, but concurrently investigate the extent of deeper contamination and incorporate containment of a deeper plume into the interim remediation plan. Our main concerns are as follows:

1) The OU-2 contamination is likely deeper than USEPA currently has defined due to strong downward vertical gradients and is not being addressed in the interim remediation plan. The vertical gradients and "plunging plume" (see Attachment A) were not incorporated into the model so the model did not accurately simulate the deeper extent of the plume.

2) The OU-2 plume (both shallow and deep) is not adequately defined at the southern end or leading edge of the plume, thereby risking failure of the interim plan to capture and contain the leading edge. Because groundwater is moving relatively quickly, and because the data are not current, the leading edge could be considerably further down-gradient than currently estimated. If the proposed remediation extraction wells are not placed at the proper leading edge, a considerable slug of contamination may be missed and continue down-gradient to potentially contaminate additional production wells.

3) Several production wells have already been contaminated by the Omega plume and others are threatened. Wellhead treatment has been required at some of these wells and other wells may have to be shut down if contamination levels get too high. USEPA should expedite interim and final remediation strategies to not only contain the existing plume footprint (as yet to be defined in the shallow and deeper aquifer systems), but to identity ways to assist pumpers whose wells have already become contaminated by the Omega plume and who, along with other agencies such as WRD, have had to install wellhead treatment systems to remove the contamination before serving the water to the public.

4) USEPA needs to be mindful of and fully understand the intricacies of the pumping rights and replenishment activities within the Central Basin and work with the various entities to ensure that the extraction, treatment, and delivery of the water meets all of the requirements of the stakeholders within the Central Basin and complies with the Central Basin adjudication regarding groundwater pumping in the basin. WRD has had extensive discussions with USEPA to explain and clarify these various roles and responsibilities of the numerous parties and regulations involved, and USEPA appears to have a working understanding at this time. However, as USEPA experienced at other nearby Superfund sites in the San Gabriel Valley, the amount of time and negotiation it takes to comply and make agreements with the numerous parties involved with the groundwater in this region cannot be underestimated.

5) A contingency plan is needed to address any potential delays with implementation of the interim remedial alternative caused by plume investigation, construction delays, securing parties to accept the treated water, complying with legal and regulatory requirements, and other issues. The plume continues to move forward with each day that passes and the current location of the southern capture wells may not be in the correct location by the time the OU-2 remediation system is finally put into operation.

SPECIFIC COMMENTS

#1: The OU-2 plume has been defined based on results from relatively shallow monitoring wells (i.e., less than 200 feet below ground surface [bgs]) in the area. From the data presented in the Tech Memo (Attachment A), there are significant downward vertical hydraulic gradients in the region which likely have led to the Omega plume plunging downward to depths greater than have been investigated. We strongly believe that further investigation of depths greater than 200 feet bgs is necessary to fully delineate the vertical and lateral extent of contamination, especially at the furthest down-gradient portion or southern end of the OU-2 plume. As one of the goals of the remediation effort is to prevent vertical migration and spreading of the OU-2 plume, confirmation of the vertical contamination extent is critical when designing an interim and final remediation solution.

WRD recommends installation of deeper monitoring wells to at least 300 feet bgs throughout the OU-2 plume area and particularly at the leading edge of the plume. Even deeper wells will be required if the contamination is found to be greater than 300 feet bgs. The data collected from these deeper monitoring wells can be used to determine the required total depths of the proposed extraction wells that will adequately control vertical migration of the deeper OU-2 plume, prevent contamination of deeper water supply aquifers, and minimize future impact to nearby drinking water wells. The results of the USGS work currently being done with WRD may help USEPA identify locations for some of the deeper monitoring wells; however, the USEPA should not wait for the results of the USGS work before initiating construction of the deeper wells, especially at the leading edge of the plume.

#2: The current conceptual model developed by USEPA depicts Golden State Water Company (Golden State) Wells Pioneer 1, 2, & 3 and Dace 1 just outside the limits of the OU-2 plume area. However, according to the FS Report, these Golden State wells have been impacted by contaminants from OU-2 and that USEPA's selected remedial alternative relies on the continued pumping of these Golden State production wells to control lateral migration of the plume. As discussed in the Tech Memo (Attachment A), WorleyParsons reached the conclusion that there is strong evidence that the Golden State Pioneer wells and likely the Dace well have been contaminated by the Omega plume. WRD is concerned that this discrepancy between USEPA's RI and FS reports, and WorleyParsons' findings may result in improper placement of the proposed remediation wells.

Additionally, there is a lack of groundwater quality data beyond the furthest down-gradient USEPA monitoring wells (see Attachment A). As a result and as stated above in Specific Comment #1, WRD recommends that USEPA install additional monitoring wells down-gradient of the currently defined location of the plume's leading edge so that the vertical and lateral extent of contamination can be confirmed and fully delineated. By doing so, the leading edge extraction wells can be constructed at locations that will adequately capture the leading edge of the plume. From the evidence presented in the Tech Memo (Attachment A), WRD believes that the Golden State wells have been impacted by the OU-2 plume and it is prudent for USEPA to revise the conceptual model to depict the Golden State wells within the OU-2 limits, so that the groundwater flow and transport model can be refined to more accurately evaluate the effectiveness of plume interception and the effects of remedial extraction on the Golden State wells.

#3: Based on USEPA's calculated advective transport velocity for contaminants in the OU-2 plume, there is a potential that the leading edge of the plume will migrate further downgradient than shown on the latest OU-2 plume maps (which are based on 2007 data) by the time the extraction wells are constructed and remediation plans are implemented. WRD recommends that USEPA develop a contingency plan in case remediation is delayed and the proposed remediation extraction wells need to be moved further down-gradient to ensure cutting off and containing the leading edge of the plume.

#4: As USEPA is aware, the Central Basin has complexities with regards to pumping rights, replenishment needs, replenishment assessments, watermaster duties, WRD duties, and the interests of the various cities and public/private utilities that provide groundwater to the overlying residents and businesses, in addition to concerned stakeholder groups. USEPA has recently performed outreach and conducted meetings with some of these groups and should continue to do so with other groups as well (i.e., individual Cities that may be affected by the contamination, Watermaster, WRD, Central Basin Water Association, Southeast Water Coalition, and public and private water utilities, such as Golden State Water Company). Due to potential delays with getting approvals to pump and deliver the groundwater as part of the interim alternative, the contingency plan mentioned in Specific Comment #3 should include USEPA's responses to potential remediation delays related to securing delivery of the treated water to selected end user(s).

The Central Groundwater Basin is a valuable drinking water resource for nearly 2.5 million residents that overlie the basin. The current and expanding threat that the approximately 4.5-mile long Omega contamination plume has on the basin is enormous and requires immediate and well thought-out action. WRD appreciates USEPA's efforts on the investigation of the OU-2 plume and is pleased that interim remediation followed by full scale remediation is being pursued.

WRD also appreciates the opportunity to comment on the proposed interim remediation plan and we trust that our comments and attached Tech Memo are helpful and support USEPA's efforts. We look forward to continuing our close working relationship in refining the details of the proposed interim and final remediation plans and would be happy to assist USEPA in any way that would expedite groundwater cleanup at the Omega site. If you have any questions regarding this letter, please contact Mr. Ted Johnson at tjohnson@wrd.org or (562) 275-4240.

Yours truly,

Robb Whitaker, P.E.
General Manager

Enclosure

ATTACHMENT A

Technical Memorandum
Omega Chemical Superfund Site
WorleyParsons
October 7, 2010

7 October 2010

Proj. No.: 308006-223-T5
File Loc.: Long Beach

Water Replenishment District of Southern California
4040 Paramount Blvd.
Lakewood, CA 90712

Attention: Phuong Ly

Dear Ms. Ly:

RE: TECHNICAL MEMORANDUM
OMEGA CHEMICAL SUPERFUND SITE, WHITTIER, CALIFORNIA

WorleyParsons was retained by the Water Replenishment District of Southern California (WRD) to support its efforts in addressing questions developed by WRD in response to the Remedial Investigation and Remedial Feasibility studies for the Omega Chemical Corporation Superfund Site (Omega Site), Operable Unit 2 (OU2), by the United States Environmental Protection Agency (USEPA).

Documents Provided by the WRD

The principal documents that were reviewed in addressing the questions provided were:

a) Remedial Investigation/Feasibility Study Reports, Omega Chemical Corporation Superfund Site, Operable Unit 2, Volume 1, by CH2M Hill for USEPA, August 2010. (the RI Report)

b) Final Feasibility Study Report, Omega Chemical Corporation Superfund Site, Operable Unit 2, Whittier, California, by CH2M Hill for USEPA, August 2010. (the FS Report)

c) Proposed Plan for OU-2 Groundwater Contamination, Omega Chemical Corporation Superfund Site, by USEPA, August 2010. (the Proposed Plan)

In addition, historical groundwater quality data was provided for the following Golden State Water Company (GSWC) production wells:

- Pioneer 1, 2, 3
- Dace 1
- Imperial 1, 2, 3

Laboratory analytical reports for the USEPA's February 2010 sampling of the Pioneer 1, 2, and 3 wells and the Dace 1 well were also provided.

Response to Questions Developed by the WRD

In the remainder of this document, the questions provided to WorleyParsons by WRD are shown in bold text. The WorleyParsons response follows each question. For reader convenience, cited figures from the RI Report and the FS Report are included in Attachment A and Attachment B of this document, respectively.

Question 1. Do you agree with the conceptual model developed by USEPA on the hydrogeological conditions and plume configuration of the OU-2 area, particularly with respect to the locations and total depths of the monitoring wells installed for the RI/FS? Discuss the weaknesses, if any.

The key elements of the USEPA conceptual model (RI Report, Section 6) for OU2 of the Omega Site include the following:

- Known total depth extent of contaminants is approximately 200 feet in the OU2 area; and the depth of contamination increases downgradient of the Omega Site;
- The contamination found at GSWC Wells Pioneer 1, Pioneer 2, Pioneer 3, and Dace 1 likely extends to their upper screen intervals centered at about 200 feet bgs; however, VOC contamination was not found in the shallow groundwater (near the water table) in this area;
- The rate of Tetrachloroethene (PCE) and Trichloroethene (TCE) degradation is slow compared to their migration rate, and therefore they occur in groundwater throughout the OU, as does 1,4 dioxane, which doesn't readily degrade;
- 1,1,1-Trichloroethane (1,1,1-TCA), PCE, and TCE degradation byproducts occur throughout the OU; PCE and TCE degradation occurs primarily at the source areas and not further downgradient;
- Advective transport velocity, including sorption, is most likely 620 feet per year; however, advective velocities several times higher are possible;
- Numerical modeling supports the conceptual model and shows that the plume from the Omega Site has comingled with the Angeles Chemical – McKesson (AMK) sites located 1.3 miles downgradient (11 years travel time);
- Shallow groundwater contamination has the potential to impact deep aquifers in the Central Basin due to the drawdown of deep aquifer groundwater levels due to pumping, and the evidence of meteoric water mixing with deep groundwater in the Central Basin

The following comments address key elements assumptions of the USEPA conceptual model.

The vertical extent of contamination in the RI Report is likely under-represented (i.e., greater) in the downgradient part of OU2. The furthest downgradient monitoring well cluster with vertical delineation of the PCE or TCE plume is MW27; downgradient (south) of that well cluster, there is no vertical delineation of the plume. Figure 4-8 of the RI Report, cross-section C-C', shows the absence of vertical delineation between MW27 and MW29. There are two key lines of evidence that indicate that contamination is likely deeper than indicated in the RI Report, as follows:

a) OU2 is located in a regional recharge area dominated by downward vertical hydraulic gradients, indicating a downward component of groundwater flow. As noted in RI Report Section 4.5.2.4 (p. 4-7),

"*The greatest difference between water levels in adjacent screens is 25.69 feet between Wells MW25C and MW25D. Water level differences of 10 to 20 feet were measured at six locations (or wells)—between OW3 and OW3B, OW8 and OW8B, MW17B and MW17C, MW20B and MW20C, MW26B and MW26C, and MW27B and MW27C*".

Although not calculated in the RI Report, the vertical head difference between shallow and deep wells represents a downward vertical hydraulic gradient, which for the well pairs listed above ranges from 0.22 to 0.49 ft/ft, as calculated in Table 1.

Table 1. Vertical Hydraulic Gradients in OU2

Well Name	SB	Depth to Screen Top (ft bgs)	Depth to Screen Bottom (ft bgs)	Water Level Elevation (ft msl)	Screen Midpoint Depth (ft bgs)	Delta L (ft)	Delta H (ft)	Vertical Hydraulic Gradient* (ft/ft)
OW3A	2	63	83	133.72	73			
OW3B	3	112	122	120.56	117	44	13.16	0.30
OW8A	2	60.4	80	133.94	70.2			
OW8B	3	116	126	120.96	121	50.8	12.98	0.26
MW17B	4	94	104	95.24	99			
MW17C	6	172	182	77.76	177	78	17.48	0.22
MW20B	4	122	132	74	127			
MW20C	5	180	190	55.5	185	58	18.5	0.32
MW25C	6	140	150	106.01	145			
MW25D	7	194	209	80.32	201.5	56.5	25.69	0.45
MW26B	4	105	120	88.33	112.5			
MW26C	6	145	160	74.86	152.5	40	13.47	0.34
MW27B	4	144	164	62.34	154			
MW27C	5	180	190	47.1	185	31	15.24	0.49

Notes: bgs - below ground surface
msl - mean sea level
L = distance
H = hydraulic head
Data from RI Report Table 4-1
SB - stratigraphic unit number
*Sign convention: +ve downward, -ve upward

These are clearly significant gradients in comparison to the average horizontal hydraulic gradient of 0.0049 ft/ft (RI Report p. 4-8). Recognizing that vertical hydraulic conductivity (K) is likely to be 10 to 100 times lower than the horizontal K, even a 100 times lower vertical K would give a vertical groundwater flux that is on the same order of magnitude as the horizontal flux. Moreover, a vertical K 1000 times lower than the horizontal K would give vertical flux that is 10% of the horizontal flux, which would still result in significant downward movement of contaminant mass due to the very large surface area for vertical flow (surface area of the aquitard) versus the relatively small cross-sectional area of the aquifer for horizontal flow. Consequently, downward plume migration is expected to be significant, and greater than represented in the report.

The observed downward vertical gradients occur between different stratigraphic units at different well clusters, reflecting as noted in the RI Report (p. 4-10) that "*Aquitards are generally not contiguous over OU2…there is no single, continuous aquitard present at OU2*". Where the indicated discontinuities in aquitards occur, the potential for downward vertical migration of contaminants could be substantial. Such discontinuities appear to be common in OU2, and the resulting downward vertical migration of contaminant also appears to be widespread. A particularly good example of this downward migration is observed at MW23, where the very high concentrations observed in MW23C at 160 ft depth could be related to an upgradient discontinuity in the aquitard between stratigraphic units 4-5 and unit 6.

b) The second line of evidence that indicates that contamination is likely deeper than indicated in the RI Report pertains to stratigraphy. The PCE plume at well cluster MW27 extends to well MW27C, which is completed in stratigraphic unit 4. As shown in cross-section C-C', stratigraphic unit 4 dips in the downgradient direction, such that at the location of MW29 the base on this unit is approximately 270 feet deep. Even considering only the horizontal component of groundwater flow in this unit, it is likely that the plume will extend to depths appreciably greater than 200 feet between MW27 and MW29. Unfortunately, the three main wells that the RI Report relies on for downgradient delineation of the plume, MW28, MW29 and MW30, are all completed at depths of 115 feet or less.

The USEPA conceptual model appears to be predicated on the concept that contamination that enters the water table at the Omega site will subsequently migrate in shallow groundwater near the water table for the entire length of the plume, while recognizing that downward vertical migration will occur simultaneously. The USEPA conceptual model does not recognize the concept of a plunging plume, which is very commonly observed at contaminated sites. In a system with significant downward vertical components of flow, areal recharge of 1.5 to 2 inches per year (as quoted in the RI Report based on USGS work), there is no driving force to maintain the plume at shallow depths, in the absence of additional downgradient sources of contamination. Consequently, it is reasonable to expect the downgradient plume to gradually dive below the water table and into deeper groundwater.

The RI Report concludes that "*The PCE plume likely extends to a depth of about 200 feet bgs in the area of the Pioneer wells (west of the downgradient portion of the OU2 plume) where the contaminated groundwater is extracted via the upper screen intervals of the wells*." (RI Report p 5-34) Regarding the Dace 1 well, the RI Report concludes that "*it is not known whether the PCE plume (defined by concentrations greater than the MCL of 5 µg/L) has reached this area*." (RI Report p 5-34). This conclusion is based solely on the February 2010 sampling event, and does not acknowledge that PCE concentration in this well was 13 ug/L as recently as April 7, 2009. In spite of these conclusions, none of the plume maps in the RI Report show the OU2 plume(s) extending to the location of the GSWC Pioneer or Dace 1 wells (the maps do not even include the GSWC well locations on them), presumably because of the absence of a shallow groundwater plume in these locations. There is no compelling reason why a plume in shallow groundwater is required to overlie a deeper plume, as suggested by USEPA to rationalize that the OU2 plume does not extend to the locations of the GSWC Pioneer and Dace 1 wells.

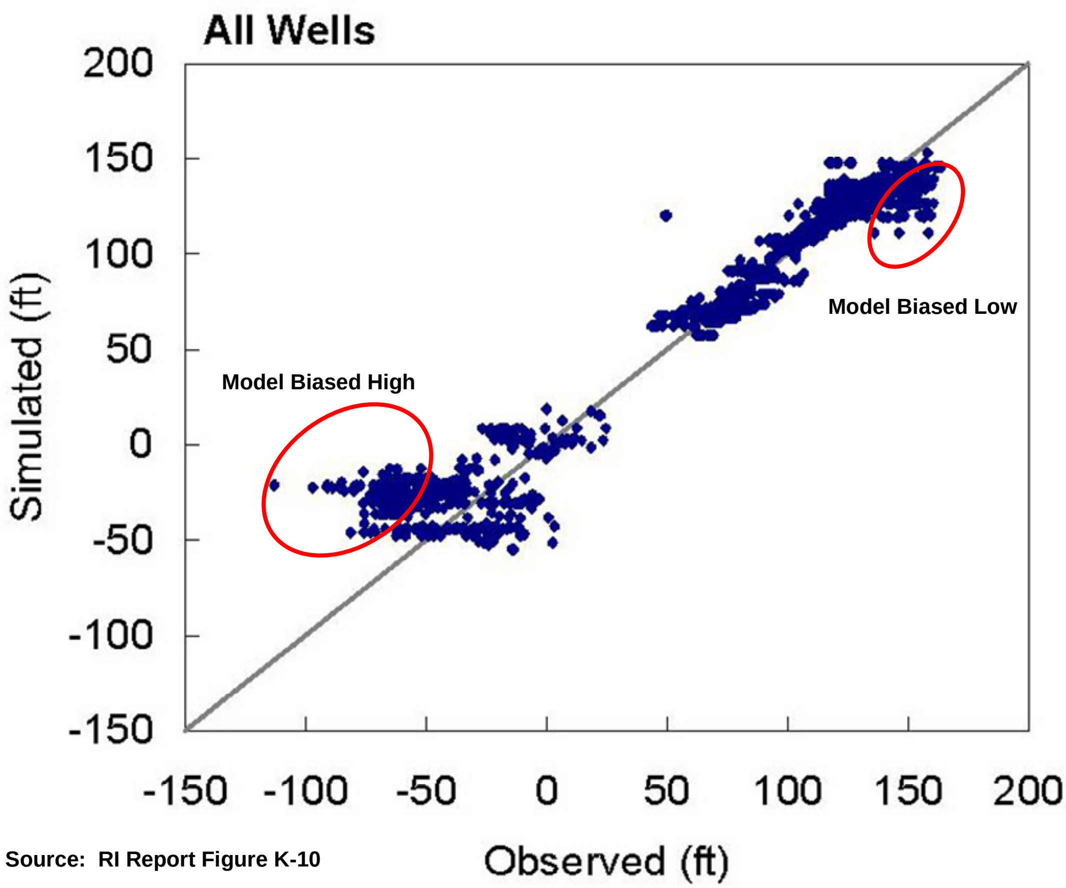
2. Do you think the groundwater modeling work conducted for the RI/FS was valid and adequate? Discuss the weaknesses, if any.

The groundwater flow and transport model developed for the OU2 RI and FS is based on the USGS model of the Central and West Coast Basins (Reichard et al., 2003), with mesh refinement in the OU2 area. The USGS model is a very coarse regional model but it is suitable for providing boundary conditions and flow field beyond the detailed OU2 model area.

Two versions of the OU2 model were developed – an initial version for the RI Report, and a refined version of the model for the FS Report, which includes enhanced calibration using the automated calibration tool PEST, with the pilot point method. Despite numerous shortcomings in terms of the completeness of model documentation (e.g., no water or solute mass balances presented; no tabulations or pumping rates for production wells, etc.) the modeling is generally reasonable. However, several key deficiencies are noted in the comments below, some of which are conceptual model deficiencies carried forward into the numerical simulations.

An important weakness of the RI model is its inability to accurately represent the vertical head differences, and therefore the vertical hydraulic gradient, between the upper stratigraphic units and deeper units in which contamination is observed, particularly stratigraphic units 4 to 6. As noted in the response to Question 1, the difference in groundwater elevation between shallow and deep stratigraphic units is commonly 10 to 20 feet, and these head differences represent significant downward vertical hydraulic gradients. However, there is bias in the RI Model such that simulated groundwater elevations in shallower units with higher groundwater elevations are biased low, while at the same time simulated groundwater elevations in deeper units with lower groundwater elevations are biased high, such that the net effect is a simulation that under-represents the vertical head difference and therefore, the downward vertical gradients (i.e., downward contaminant migration). This bias can be observed in the scatter plot of observed versus simulated heads in Figure K-11 of the RI Report, a portion of which is represented in Figure 1, below:

Figure 1. Scatter Plot of Simulated and Observed Water Levels, Excerpted from RI Report Figure K-10.

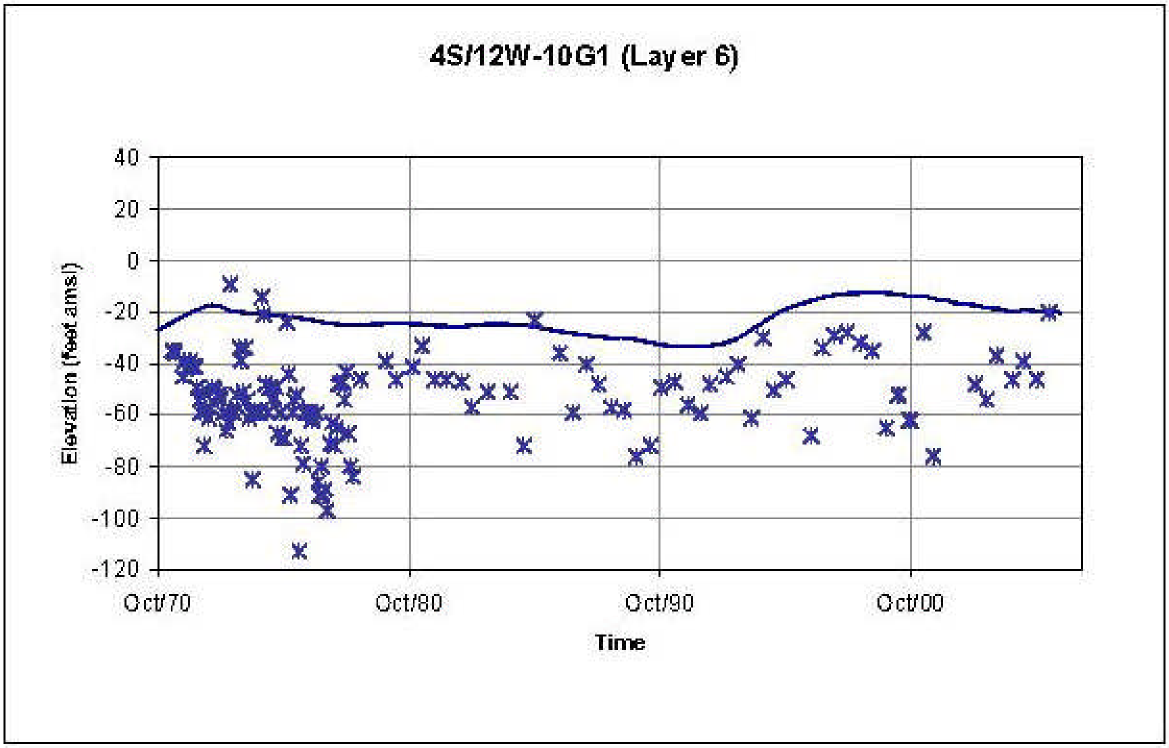


Source: RI Report Figure K-10

As noted in the circled areas in Figure 1, above, the magnitude of the bias in the model is commonly 20 feet or more in the highest and lowest heads in the model, effectively negating any downward vertical gradient.

Another example of the bias in the modeled heads is shown in the transient calibration against observed hydrographs, an example of which is shown in Figure 2 below, from Figure K-12 of the RI Report:

Figure 2. Simulated and Observed Hydrographs, Excerpted from RI Report Figure K-12.



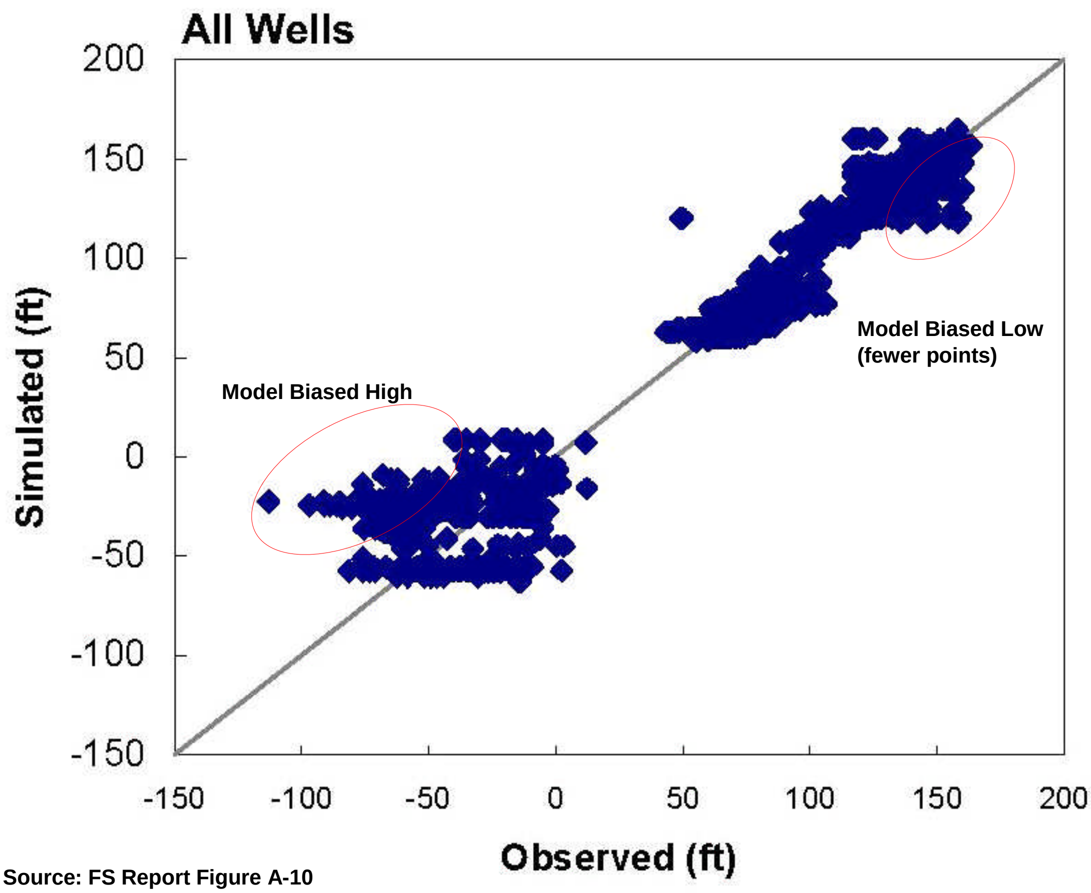
Source: RI Report Figure K-12

The above plot shows that simulated groundwater elevations for a deeper model layer (layer 6; stratigraphic unit 4) are consistently high compared to observed values. Again, the effect of this bias is to underestimate the vertical hydraulic gradient.

Given this bias in the simulated groundwater elevations, it is not surprising that the groundwater model does not adequately simulate downward contaminant migration.

The refined groundwater model of the FS Report shows less bias in the simulated groundwater elevations, although there is still appreciable bias of the same kind shown in the RI model. The scatter plot from Figure A-10 of the FS Report is shown in Figure 3, below:

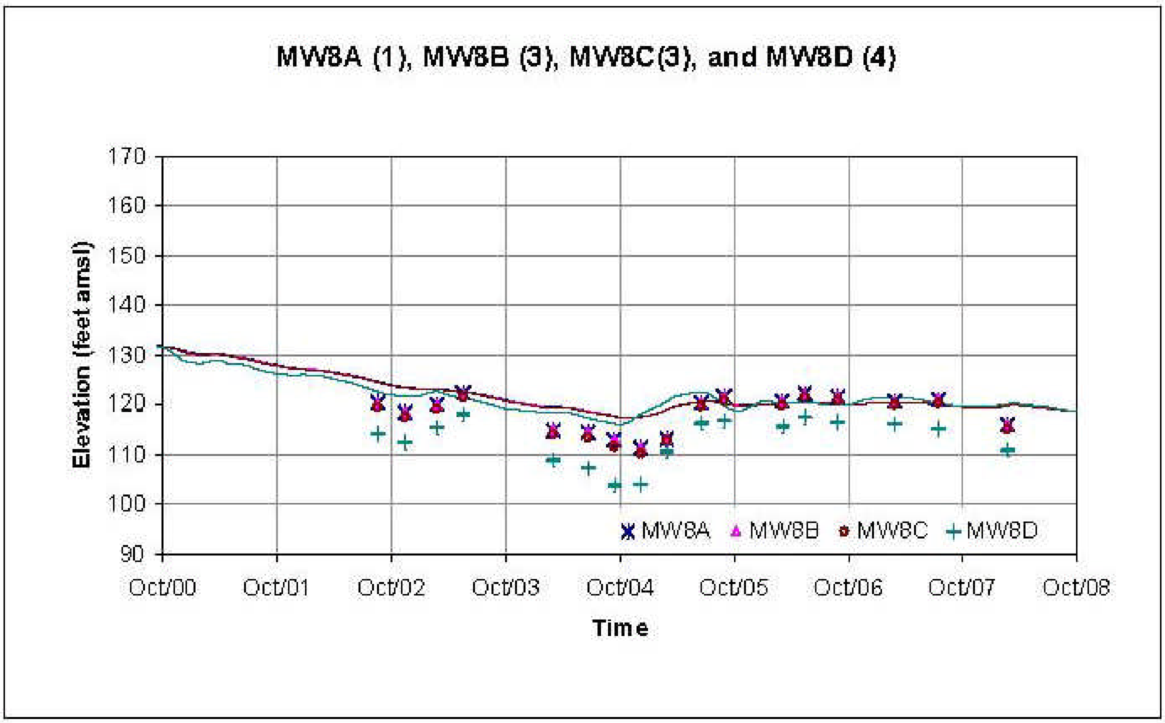
Figure 3. Scatter Plot of Simulated and Observed Water Levels, Excerpted from FS Report Figure A-10



Source: FS Report Figure A-10

Similarly, the transient model hydrograph in the FS model still shows that while groundwater elevations in shallow units are generally well simulated, groundwater elevations in deep units are still simulated high, again under-representing the vertical hydraulic gradient. For example, the following transient calibration hydrograph (Figure 4) is from FS Report Figure A-11:

Figure 4. Simulated and Observed Hydrographs, Excerpted from FS Report Figure A-11.



Source: FS Report Figure A-11

One of the biggest limitations of both models is not with the models themselves, but the conceptual model that is used as their basis. The RI model attempts to match the PCE plume depicted in the RI Report, which incorrectly represents the plume extent in deeper zones (stratigraphic units 4 and 5) and excludes the portion of the plume that extends to the GSWC Pioneer and Dace 1 wells, despite the previously-quoted conclusion of the RI Report that groundwater is extracted via the upper screen intervals of the Pioneer wells (RI Report p 5-34; see Question 1). Since this incorrect plume mapping is the basis for matching in the transport model, the model of course shows that the simulated plume also does not extend to the GSWC wells.

The FS version of the model better represents the vertical differences between shallow and deeper units, and even though it starts with the same incorrect plume extent from the RI conceptual model, the FS simulation results show that the plume is currently captured by the GSWC Pioneer wells. As stated in the FS Report (p. 3-5), "*The modeling indicates that these wells are capturing some of the* *contaminated groundwater from OU2 and currently are providing some degree of the containment at the leading edge.*"

3. Do you agree with the OU-2 plume size depicted in the RI/FS, after reviewing the water quality data from the downgradient Golden State Water Company (GSWC) wells? If not, please tell us how you think the OU-2 plume size should be redrawn? Do you believe the vertical extent of contamination has been adequately addressed?

As discussed in the response to question 1, there is strong evidence for downward vertical groundwater flow and contaminant migration within OU2, and vertical delineation in the downgradient portion of the plume is entirely incomplete. Once contamination has migrated to a deeper stratigraphic unit, the groundwater flow direction in that unit may be naturally different than shallower units, or there may be stresses such as production well pumping, that influence the groundwater flow direction (and plume migration) within the deeper units independently of migration in shallower units. Lowering of groundwater levels in deeper aquifers due to pumping does not only influence (increase) downward vertical migration of contaminants, but also lateral migration within the wells' capture zone. The GSWC Pioneer 1, 2, 3 and Dace 1 wells have screen sections that are likely completed within stratigraphic units 4 and 5 (Wells Pioneer 1: 193-216 ft; Pioneer 2: 196-206 feet upper screen; Pioneer 3: 194-218 ft upper screen; Dace 1: 200-260 upper screen). The furthest downgradient OU2 wells in these units are at MW27, which has (high) concentrations of PCE and TCE of 140 and 120 ug/L, respectively in MW27C, in stratigraphic unit 4. There is no lateral delineation of this contamination in either the downgradient or cross-gradient direction from MW27, so the lateral downgradient extent of contamination in this zone is unknown. This is of particular concern to the southwest and south where the GSWC Pioneer and Dace 1 wells, respectively, are located close to the edge of the plume as mapped by USEPA.

The GSWC Pioneer 1 and 3 and Dace 1 wells had TCE and PCE concentrations exceeding the maximum contaminant level (MCL) of 5 ug/L in the 2005 to 2007 time period (see data tabulated in Question 4 response) that should have been considered by USEPA in drawing the plume outlines for TCE and PCE in the RI Report. The plume outlines in the RI report are composite plume outlines that are supposed to reflect contamination in all the underlying units. The evidence is unequivocal (see response to Question 4) that the GSWC Pioneer and Dace 1 wells were impacted by the OU2 plume at levels greater than the MCL during the time period considered by the RI Report. The plume outline for PCE that are shown in RI Report Figure 1-4 as dashed and characterized as "*potential deep (about 200 feet below ground surface) PCE extent*" should be simply drawn as part of the composite PCE plume outline. Presumably, the same comment also applies to the TCE composite plume. Moreover, downgradient delineation of the deeper zone plume may extend beyond these GSWC wells, and the plume outlines in the RI Report should reflect this uncertainty in the downgradient delineation of the OU2 plumes.

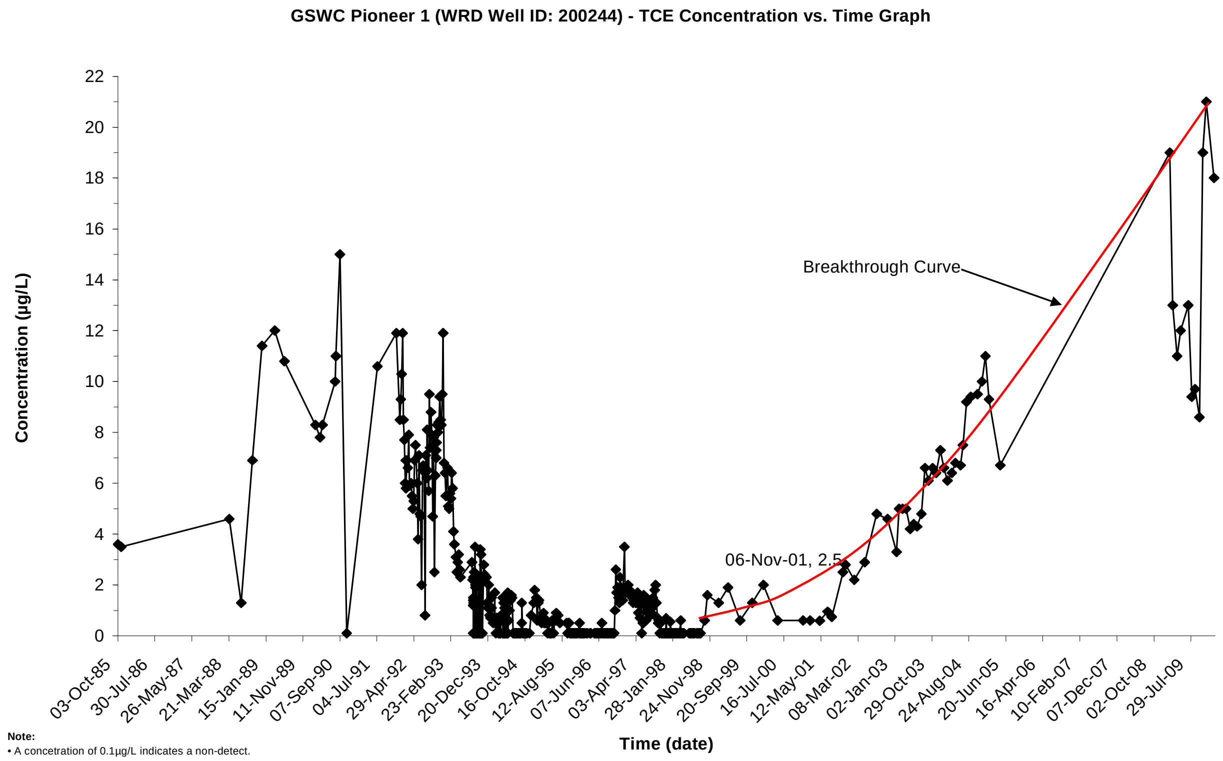
4. Based on your review of the analytical data from the Omega Chemical monitoring wells and the production wells, is it possible that the contaminants detected in the production wells (specifically, GSWC Wells Pioneer 1, 2, & 3, Imperial 1, 2, & 3, and Dace 1) are related to the Omega Chemical site or could the contamination come from a different source? Please discuss.

There is strong evidence to indicate that the GSWC Pioneer wells, and probably the Dace 1 well, have been impacted by contaminants from the Omega Site, and are therefore presently within the limits of the Omega plume, which is only considered as a "potential" by USEPA. First is the suite of contaminants detected at these wells. Considering only compounds that have been detected at least three times (to eliminate anomalies), all of these wells have detected 1,1-Dichloroethene (1,1-DCE) , 1,4 Dioxane, PCE, and TCE. Pioneer 1, 2 and 3 have also detected 1,1,1-Trichloroethane (1,1,1-TCA), and Pioneer 1 has also detected 1,1-Dichloroethane (1,1-DCA). According to the Summary of Sources of Contamination in Table 6-4 of the RI Report, only the former AMK sites in addition to the Omega Site have this full suite of contaminants. In addition, Freon 11 and 113 were also detected at low concentrations (0.5 and 1.2 ug/L, respectively) in GSWC Well Pioneer 1 during the February 2010 sampling by USEPA. These chemicals are considered "... *tracers for the Omega Contaminants because the former Omega facility is the only confirmed source of Freons that have impacted OU2 groundwater*." (FS Report p. 1-11) These constituents were not analyzed as part of GSWC's historical water quality monitoring.

There are nine other sites (listed in Table 6-4) that are sources of PCE, TCE, and 1,1-DCE as found in the Dace 1 well, making its potential source(s) of contamination less unique, but still likely within OU2.

Another line of evidence that contamination in at least the Pioneer wells is from the Omega plume is the observed breakthrough of PCE and TCE at these wells. The breakthrough of TCE in the Pioneer 1 well is shown in the following time series plot (Figure 5):

Figure 5. Time-Series Plot of TCE in the Pioneer 1 Well, Showing Breakthrough Curve for TCE.

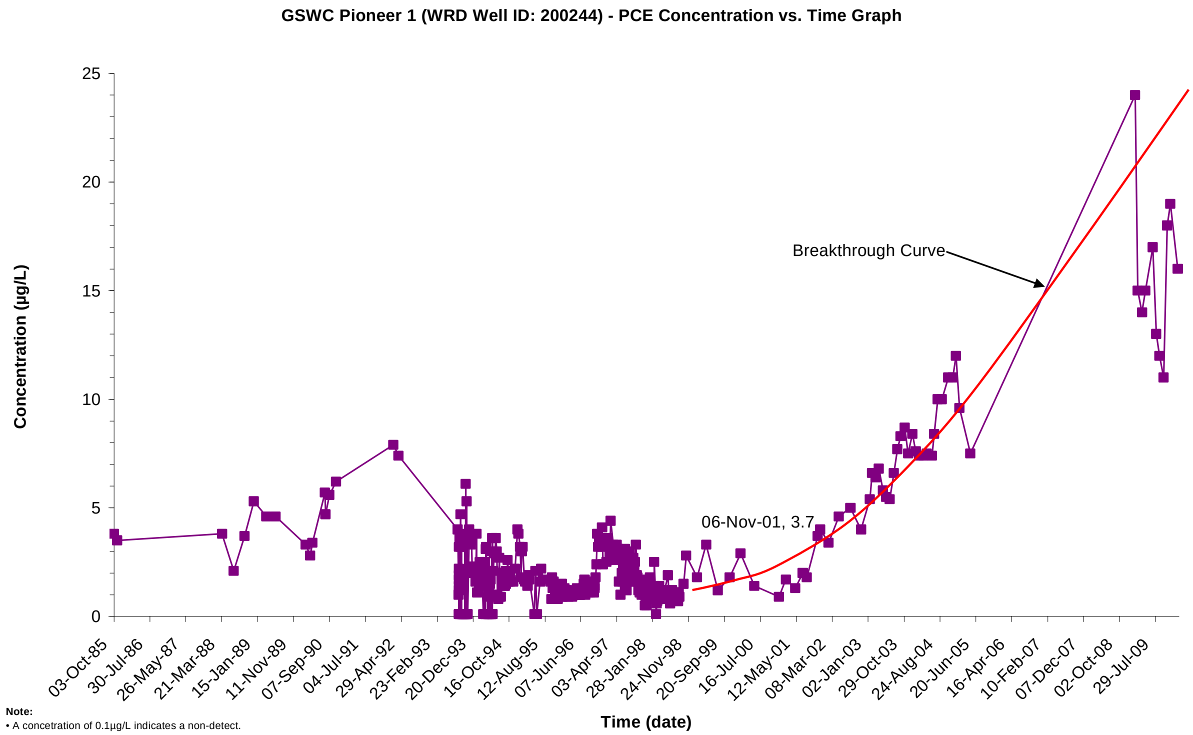


Source: : WRD Database

The breakthrough of TCE in the well begins somewhere between late 1998 and late 2001, but is clearly in progress by November 2001. Pre-mid 1990's TCE appears to reflect a different regional plume that passed through the well from the mid 1980s until about 1996.

A similar pattern of breakthrough is observed for PCE in the Pioneer 1 well, as shown below (Figure 6):

Figure 6. Time-Series Plot of TCE in the Pioneer 1 Well, Showing Breakthrough Curve for PCE.



Source: : WRD Database

This time series graph shows the same breakthrough curve as for TCE, again beginning between late 1998 and late 2001, but clearly in progress by November 2001. These first arrival times represent a theoretical travel time of 22 to 25 years from the start of operations at the Omega and AMK sites in 1976. These travel times therefore correspond to a groundwater velocity for first arrival of TCE and PCE of 800 ft/year to 909 ft/year. Recognizing that first arrival time is appreciably faster than the advective velocity (as noted in the RI Report) and the several times factor of uncertainty in the USEPA's 620 ft/yr average advective velocity, the above travel times are well within reason for a source at the Omega/AMK sites (note that travel time from the AMK Sites would be 11 years less than that from the Omega Site (RI Report p 6-18) at an advective velocity of 620 ft/year).

The TCE and PCE breakthrough curves for Pioneer 3 are very similar to Pioneer 1, but first arrival appears later (December 2003) probably due to dilution of the plume water with water from deeper screened intervals. The breakthrough curves for Pioneer 2 are qualitatively similar to Pioneer 1, but with much more variability, and probably reflecting a different capture zone than Pioneer 1 and 3.

The Dace 1 well also shows a strong breakthrough curve of PCE beginning approximately May 2000. TCE breakthrough is much noisier, but also appears to begin in early to mid 2000. At a distance of approximately 25,000 feet from the Omega site, and first arrival time of 24 years, the first arrival groundwater velocity would be 1040 ft/yr, which is still within the plausible range given the factors noted above.

Finally, the relative proportions of TCE to PCE in the groundwater from the Pioneer wells is consistent with those in the Omega plume. As noted in the RI Report conceptual model discussed in Question1, TCE and PCE degradation processes appear to be slow compared to the rate of plume migration, and therefore it is reasonable to expect the relative concentrations of these to remain relatively constant as the plume migrates, subject to variations in source concentrations and small differences in retardation due to hydrophobic sorption. In Section 5.7.5 of the RI Report, an attempt is made to characterize the relative VOC concentrations in each well. However, the large number of contaminants and sources in OU2 presents a confusing picture. On the other hand, the plumes of PCE and TCE in OU2 present a logical, hydrogeologically consistent and mappable picture of these contaminant plumes. If one were to overlay the TCE plume on the PCE plume, a consistent picture of contaminant migration would be evident. As a simplified proxy for this overlay, consider only the relative concentrations of TCE to PCE in OU2. Table 2 below gives the ratio of TCE to PCE (i.e. TCE/PCE) for the wells shown in cross section C-C’ in Figure 4-8 of the RI Report.

Table 2. TCE/PCE Ratios for Cross Section C-C'

Well	Zone	SB	Depth to Screen Top (ft bgs)	Depth to Screen Bottom (ft bgs)	TCE (ug/L)	PCE (ug/L)	Ratio (TCE/PCE)
MW29	A	3	90	110	4.8	1.8	2.67
MW27	A	3	90	110	200	280	0.71
	B	4	144	164	140	120	1.17
	C	5	180	190	0.39	0.5	0.78
	D	5	200	210	4.5	0.35	12.86
MW20	A	3	75	90	37	28	1.32
	B	4	122	132	19	16	1.19
	C	5	180	190	2.9	0.26	11.15
MW26	A	3	70	90	140	200	0.70
	B	4	105	120	110	150	0.73
	C	6	145	160	95	92	1.03
	D	6	185	205	0.5	0.5	1.00
MW17	A	3	56	71	100	290	0.34
	B	4	94	104	110	80	1.38
	C	6	172	182	9.6	1.1	8.73
MW16	A	3	45	60	1.3	6.1	0.21
	B	5	106	116	18	5.7	3.16
	C	6	149	164	1.2	0.38	3.16
MW25	A	3	45	65	51	97	0.53
	B	4-5	90	110	180	110	1.64
	C	6	140	150	5.1	3.9	1.31
	D	7	194	209	0.5	0.5	1.00
MW23	A	2	35	55	360	810	0.44
	B	3	82	97	18	23	0.78
	C	5	145	160	520	510	1.02
	D	6	175	185	0.58	0.61	0.95
MW4	A	2	42.7	53	200	450	0.44
	B	3	69.7	80	120	440	0.27
	C	3	88.7	99	120	42	2.86
MW15	A	2	50	70	190	520	0.37
MW24	A	2	50	70	82	590	0.14
	B	3	110	125	0.1	0.052	1.92
	C	5	140	160	0.16	0.82	0.20
	D	6	173	178	0.095	0.19	0.50

Note: Wells are ordered from C (downgradient) to C’ (upgradient) as presented on cross-section C-C’ in RI Report

bgs - below ground surface

SB - Stratigraphic Boundary (unit)

July-Aug 2007 PCE and TCE data from RI Report Figure 4.8

The average TCE/PCE ratio for this transect through the Omega plume is 1.09 (range 0.14 to 3.16), excluding the three outliers from deep wells (MW27D, MW20D and MW17C) that were completed in stratigraphic units 5 and 6. Also, these wells had a much higher proportion of TCE than PCE with concentrations less than 10 ug/L, which possibly reflects a different source. Approximately one-half of the TCE/PCE ratios are less than 1.0.

TCE/PCE ratios for selected GSWC wells are provided in Table 3. Analytical data were selected to correspond as closely as possible to the July-August 2007 dates in the RI Report.

Table 3. Summary of TCE/PCE Ratios for GSWC Wells

Well	Date	TCE (ug/L)	PCE (ug/L)	Ratio (TCE/PCE)
Pioneer 1	5-May-05	6.7	7.5	0.89
Pioneer 1	2-Sep-09	19	24	0.79
Pioneer 2	1-Jul-05	0.8	0.86	0.93
Pioneer 2	9-Feb-09	3.3	4.6	0.72
Pioneer 3	24-Jul-07	9.3	11	0.85
Pioneer 3	6-Aug-07	6.8	7.4	0.92
Dace 1	5-Jun-07	12	6.6	1.82
Dace 1	6-Aug-07	10	4.9	2.04
Imperial 1	8-Aug-06	<0.5	0.85	< 0.59
Imperial 1	5-Mar-09	<0.5	1	< 0.5
Imperial 1	04-Aug-09	2.2	3.1	0.71
Imperial 2	02-May-07	<0.5	<0.5	-
Imperial 2	06-Aug-07	<0.5	<0.5	-
Imperial 2	04-Aug-09	<0.5	<0.5	-
Imperial 3	02-May-07	<0.5	0.69	<0.72
Imperial 3	06-Aug-07	<0.5	0.64	<0.78
Imperial 3	05-Aug-09	2.4	2.9	0.83

Note: Analytical data selected as close as possible to July-August 2007

Source: : WRD Database

TCE/PCE ratios for the Pioneer wells during the periods above ranged from 0.72 to 0.93, and are consistent with the range of values observed in the Omega plume. The TCE/PCE ratios at the Dace 1 well, while showing greater deviation from the average for the Omega plume, are still within the range of observed ratios for the Omega plume and consistent with the ratio in nearby well MW29. The further downgradient Imperial wells did not have TCE in 2007 but it reappeared in 2009, at which time the TCE/PCE ratios in the Imperial 1 and 3 wells were also consistent with those in the OU2 plume.

Consequently, to summarize, there are three lines of evidence that indicate that the contamination at the Pioneer wells, and possibly also the Dace 1 well, is associated with the Omega plume:

a) The suite of contaminants detected at the Pioneer wells is unique to the Omega and AMK sources; at Dace 1 they are consistent with the Omega and AMK sources;

b) The travel time from the Omega Site to the Pioneer and Dace 1 wells, based on observed breakthrough curve first arrival times, are consistent with expected range of advective-dispersive travel times from the Omega/AMK sources;

c) The proportion of TCE to PCE in the Pioneer wells is very similar to the average TCE/PCE ratio in the Omega plume, as would be expected if the contamination in these wells was part of the Omega plume. The TCE/PCE ratio in the Dace 1 well is within the range of values observed in the Omega plume, so an Omega source of this contamination is plausible.

5. Do you believe the selected remediation system discussed in the Proposed Plan is adequate to control vertical and lateral migration of the entire OU-2 plume and prevent the plume from impacting downgradient production wells? If not, please discuss your concerns and how you think the remediation system should be modified.

While the proposed remedial alternatives appear suitable to capture the OU2 plume in the upper aquifer zone, none of the remedial alternatives considered in the FS Report will, or are intended to, control vertical or lateral migration over the entire OU2 plume in the middle and lower portions of the aquifer zone where contamination is observed. In fact, all of the alternatives rely on downgradient production wells, particularly the GSWC Pioneer and possibly Dace1 wells to intercept the OU2 plume in the middle and lower portions of the contaminated zones. The FS Report does not define these "middle" and "lower" aquifer zones in terms of stratigraphic units, model layers, or depth intervals; however, the FS assumes that plume is limited to 200 feet depth, so presumably the upper, middle and lower portion of the aquifer zones reside between the water table and this depth.

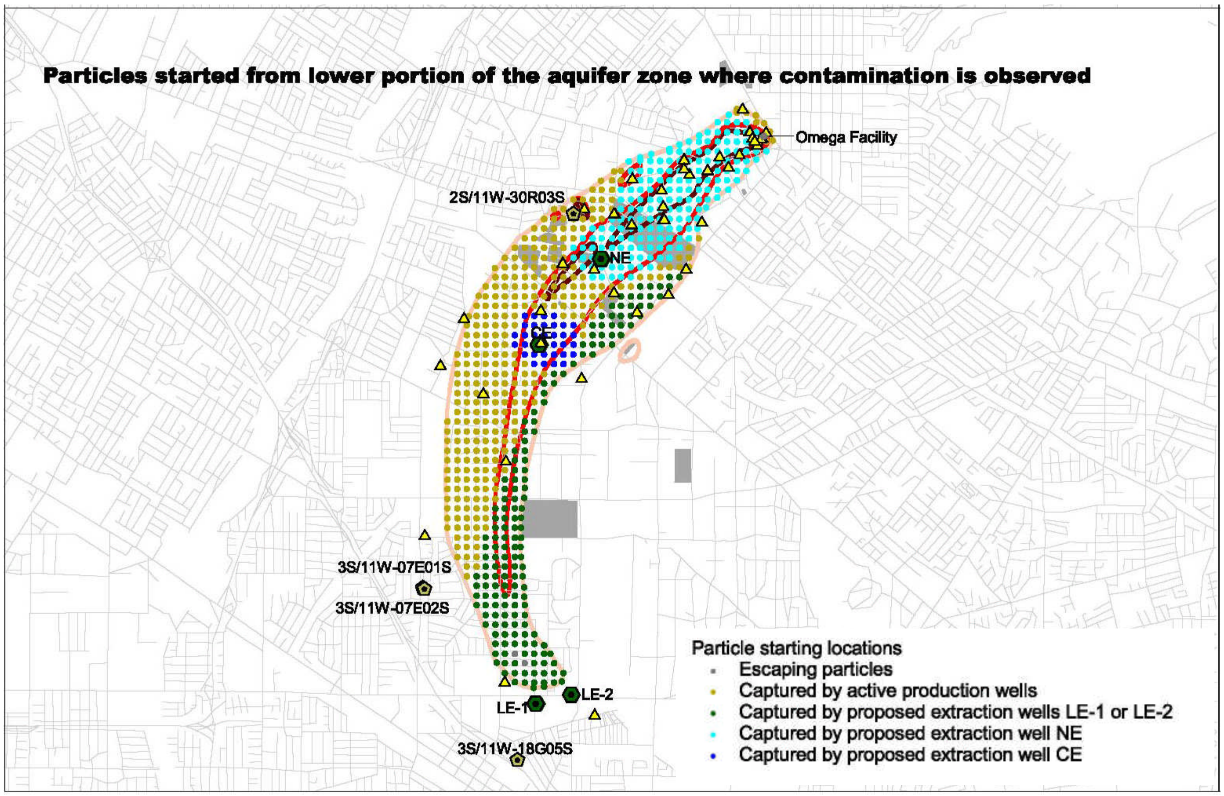
As stated in the FS Report (p. 4-19), "*Under all the alternatives, contaminants would continue to migrate toward those production wells (SFS1 and four GSWC wells) that have already captured part of the OU2 plume (unless those wells are taken out of operation). As a result, the owners of those wells will need to continue to operate the existing wellhead treatment systems indefinitely."* This conclusion is derived from the FS groundwater flow and transport modeling, which found that *". . . The modeling conducted to evaluate the pumping scenarios assumed continued operation of these production wells at their currently reported average production rate. Of particular importance are the GSWC Wells Pioneer #1, Pioneer #2, and Pioneer #3, located to the west side of OU2 LE* [leading edge]*. The modeling indicates that these wells are capturing some of the contaminated groundwater from OU2 and currently are providing some degree of the containment at the leading edge. The remedy would have to account for the operation of these production wells…*" (FS Report p. 3-5).

Capture zone modeling conducted for the FS shows that approximately one-third of the OU2 plume in the middle and lower portion of the contaminated zone will continue to be captured by the downgradient GSWC wells. FS Report Figures A-13 and A-14 show the capture zones for the leading edge and plume-wide pumping alternatives, respectively including GSWC wells Pioneer 1 (3S/11W-07E01S), Pioneer 2 (3S/11W-07E02S), and Dace 1 (3S/11W-18G05S). Under both alternatives, these figures show that these three wells will continue to capture the western one-third of the OU2 plume in the middle and lower portion of the contaminated zone.

An example of the capture zone modeling results is shown in Figure 7 for the lower aquifer zone under plume-wide extraction (complete FS Figures A-13 and A-14 are included in Appendix B). All of the yellow-colored particles are captured mainly by the GSWC production wells.

The capture zone modeling indicates that very few particles escape capture by either the extraction wells or production wells, suggesting that either the leading edge or plume wide extraction alternative (including GSWC production wells) should be able to capture the entire OU2 plume.

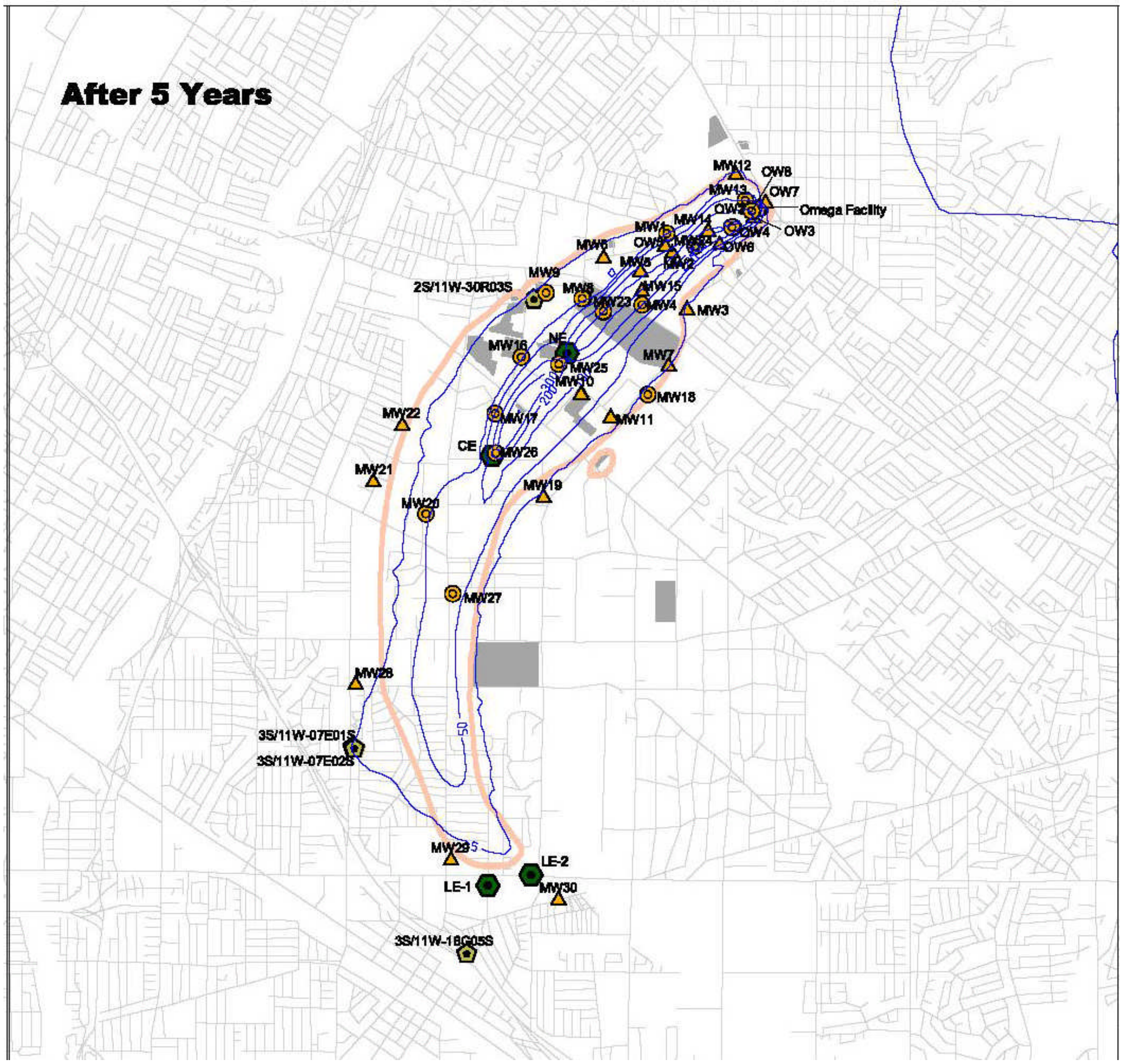
Figure 7. Capture Zone Map, Pumping Scenario with Plume-wide Extraction, Excerpted from FS Report Figure A-14.



Source: FS Report Figure A-14

The capture zone simulations are supported by the solute transport modeling of remedial extraction alternatives (FS Report, Appendix A). The transport modeling shows that for all three remedial alternatives (i.e., no action, leading edge extraction, and plume-wide extraction), the plume in the "Lower Aquifer Zone" (again, terms are not defined in the FS Report) is intercepted by GSWC Pioneer 1 and 2 wells within five years after the start of extraction. In the "Middle Aquifer Zone," the plume is intercepted by Pioneer 1 and 2 wells between 10 and 20 years after the start of extraction. Figures A17-2 and A-17-3 of the FS Report show the transport modeling results for the preferred plume-wide extraction alternative for the Middle and Deep Aquifer zones, respectively. The following Figure 8 shows the modeling results for the Deep Aquifer zone after five years of plume-wide extraction (from Figure A-17-3). Ironically, after five years of remediation extraction under the preferred alternative, the Deep Aquifer Zone plume is being intercepted by the GSWC wells, but not yet by the two leading edge extraction wells. USEPA should consider locating these wells further upgradient, so as to minimize the total volume of clean water pumped before they start to intercept the OU2 plume in excess of MCLs. It would also be appropriate to consider contingency locations (further downgradient) that reflect potential delays in system start-up.

Figure 8. Simulated PCE Plume After 5 Years of Pumping, Lower Aquifer Zone, Plume-wide Extraction Scenario, Excerpted from FS Report Figure A-17-3.



Source: FS Report Figure A-17-3

The proposed remedial alternative, including ongoing extraction from the GSWC Pioneer and Dace 1 production wells is likely to prevent further downgradient migration of the OU2 plume in the groundwater interval up to 200 feet depth. However, as noted previously, there may be significant problems with the USEPA conceptual model in terms of plume depth, particularly in the downgradient portion of the plume (for example, where the proposed leading edge extraction wells are located). The proposed depth of extraction wells in downgradient areas is based on the assumption that the plume is limited to 200 feet depth. However there are no data from this depth (or deeper) and no vertical delineation of the plume in the downgradient areas of concern. Consequently, while in the two-dimensional (plan) view, the proposed remedial alternative appears effective in capturing the entire OU2 plume, but there is a very great risk that a deeper portion of the plume (below 200 ft depth) could bypass the remedial extraction wells and pose an ongoing threat to farther downgradient wells, such as the GSWC Imperial wells (which may already be seeing some leading-edge contamination from the OU2 plume). Additional downgradient plume delineation is required, and if needed, the leading edge extraction wells should be deeper.

In terms of the GSWC Pioneer wells, there is no intention in the USEPA FS to attempt to save these wells from further contamination from the OU2 plume. In fact, it is the clear intent to sacrifice these wells as permanent remediation wells for the OU2 plume. Since these wells are already intercepting the OU2 plume, it may take some time to reverse the impact (for example, by installing additional remedial extraction wells upgradient of the Pioneer wells toward the western side of the OU2 plume). The potential also exists, however, that such remedial extraction could affect the water availability to the GSWC wells. In any case, both the effectiveness of plume interception and the affect on GSWC well yield could be evaluated using the FS groundwater flow and transport model. In terms of the Dace 1 well, the proposed leading edge extraction appears to provide plume interception for this well, although it may take several years for existing concentrations to be reduced. This comment also carries the caveat regarding the proposed extraction well depth versus possible deeper contaminant plume as discussed above.

6. All the downgradient GSWC wells will continue to pump once the remediation system discussed in the Proposed Plan begins operating. Can this affect the effectiveness of remediation activities? If so, how? Provide details.

As noted in the response to question 5, the USEPA's preferred remedial alternative depends on ongoing pumping of the GSWC Pioneer wells, probably indefinitely. Dace 1 well pumping is also considered in the groundwater flow model, and pumping from the Imperial wells is also understood to be included via the original USGS Central Basin model. In other words, ongoing pumping of GSWC's downgradient wells has been considered in the USEPA's proposed remedial plan, and should not affect the remedial implementation unless GSWC changes its pumping patterns appreciably. This comment is subject to the limitation in USEPA's conceptual model and numerical models, as previously discussed.

The proposed remedial plan is based on continued pumping from the GSWC Pioneer wells (1 and 2, at least) at their historic average rates. The GSWC Pioneer wells are an integral part of USEPA's remedial plan, and therefore the effectiveness of remediation could only be affected if these wells were to reduce or cease pumping. In this case, it would be likely that control of the western portion of the OU2 plume would be lost.

One aspect of USEPA's reliance on continued GSWC's pumping and treatment as an integral part of OU2 remediation that is not addressed in the FS Report arises from the question, "What happens if OU2 contaminants that are not amenable to treatment with GSWC's existing system reach the Pioneer wells at level exceeding drinking water criteria?" Of particular concern is 1,4-Dioxane which is already present in the Pioneer wells at concentrations exceeding the 3 ug/L Notification Level.

CLOSURE

The scope of this review was limited to those portions of the documents provided that were deemed necessary to address the questions presented by the WRD. We did not undertake a comprehensive review of all of the documentation provided. Nonetheless, we trust these comments are helpful to WRD in providing a response to USEPA's proposed remediation plans for the Omega OU2 plume. Should you have any questions or concerns, please contact the undersigned at (310) 547-6357 or by e-mail at mark.trudell@worleyparsons.com.

Sincerely,
WorleyParsons

Mark Trudell, Ph.D., PG, CHG
Principal Hydrogeologist

Steve Winners, PE
Principal Environmental Engineer

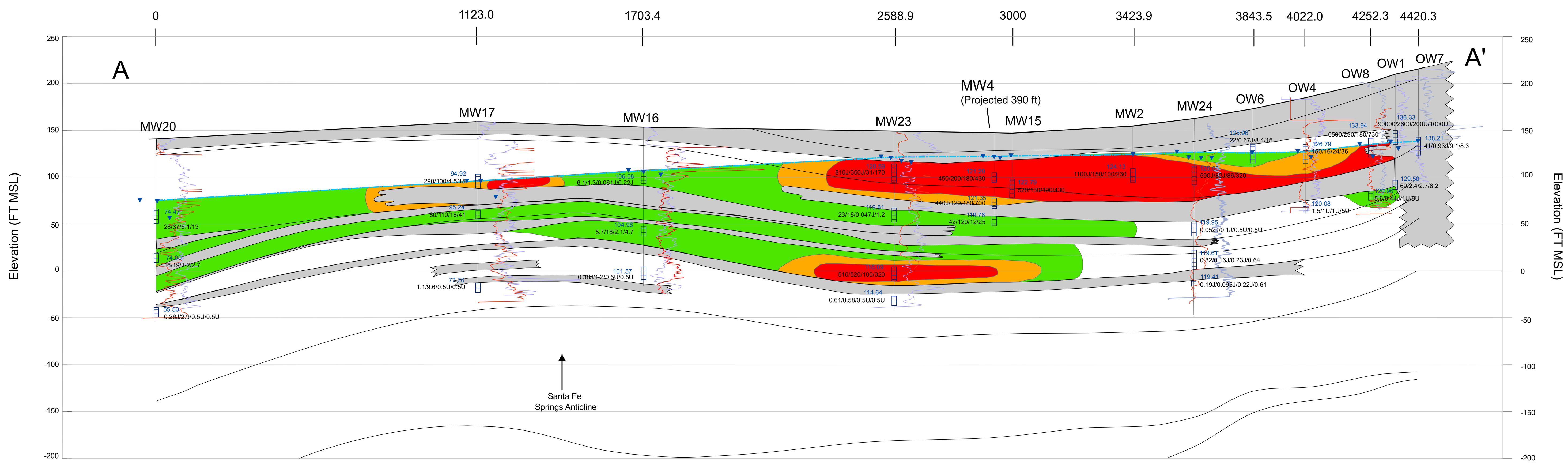
REFERENCE

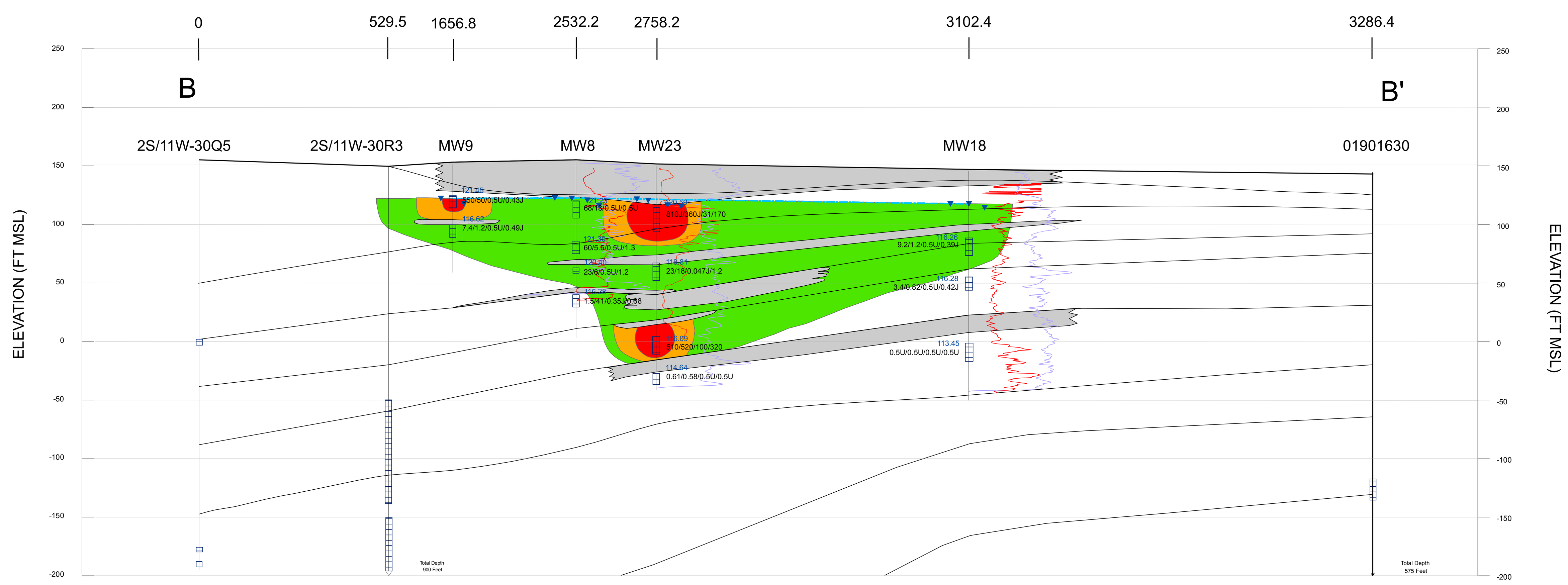
Reichard, E.G., M. Land, S.M. Crawford, T. Johnson, R.R. Everett, T.V. Kulshan, D.J. Ponti, K.J. Halford, T.A. Johnson, K.S. Paybins, and T. Nishikawa. 2003. “Geohydrology, Geochemistry, and Ground-Water Simulation – Optimization of the Central and West Coast Basins, Los Angeles County, California.” Water Resources Investigations Report 03-4065. U.S. Geological Survey.

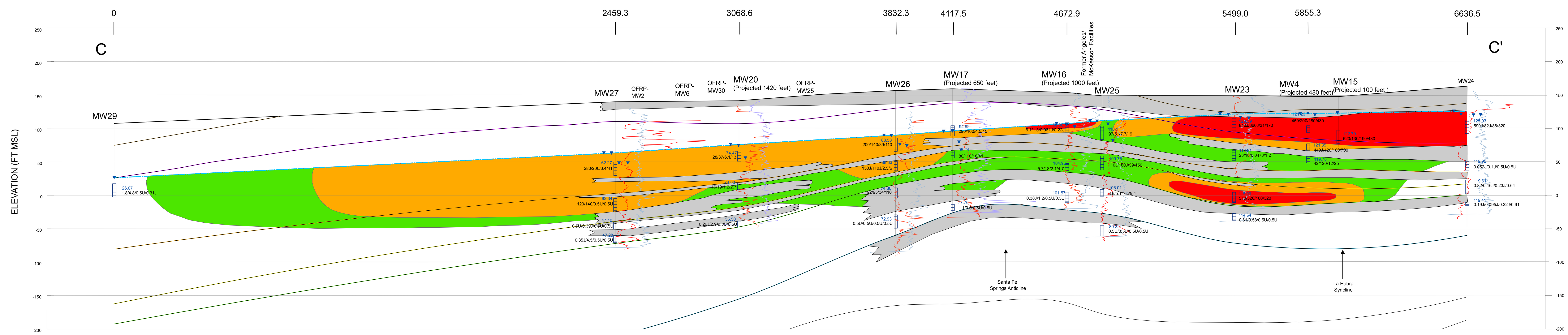
resources & energy

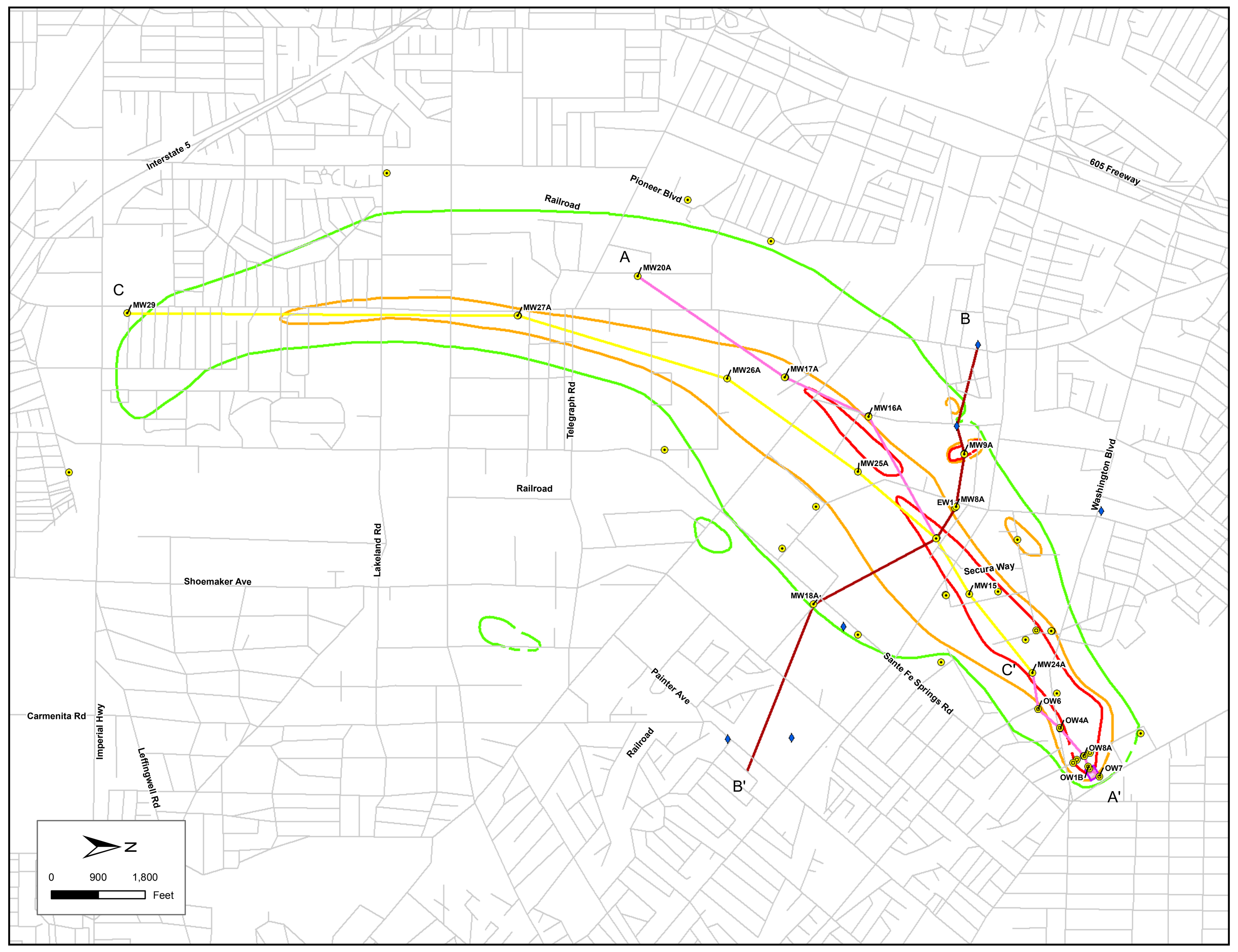
ATTACHMENT A

CITED FIGURES, RI REPORT









Legend

Cross Sections

Geophysical Logs
- Gamma
- Resistivity
- Fine-Grained Unit

Water Level
- Water Level Elevation (ft msl)
- Water Table
- Stratigraphic Boundaries

Composite PCE Distribution
- > 5 ug/L
- > 100 ug/L
- > 500 ug/L

Concentration

120.25 Water Level

0.61/0.58/0.5U/0.5U = PCE/TCE/Freon 11/Freon 113 collected in July-August 2007

Cross Section Location Map

- EPA Monitoring Well (July 2007)
- Omega Potentially Responsible Parties Organized Group (OPOG) Monitoring Well (August 2007)
- Production Well

Cross Section
- AA'
- BB'
- CC'

Composite PCE Plume Extent
- 5 ug/L (Dashed where Approximate)
- 100 ug/L (Dashed where Approximate)
- 500 ug/L (Dashed where Approximate)
- Former Omega Facility

Notes:
1) PCE = Tetrachloroethene
2) TCE = Trichloroethene
3) F11 = Freon 11
4) F113 = Freon 113
5) U = Non-Detect; J = Estimated Value; R = Rejected Value
6) SB - Stratigraphic Boundary
7) FT MSL = Feet Above Mean Sea Level
8) Smooth (finger-like) lateral termination of fine-grained units represents facies change into coarse-grained material. Jagged termination is used when extent is unknown.
9) Stratigraphic interpretation is also based on deep seismic reflection data (not shown)

Figure 4-8
Hydrogeologic Cross Sections with Location Map

Omega Chemical Superfund Site

CH2MHILL

Date: May 30, 2008

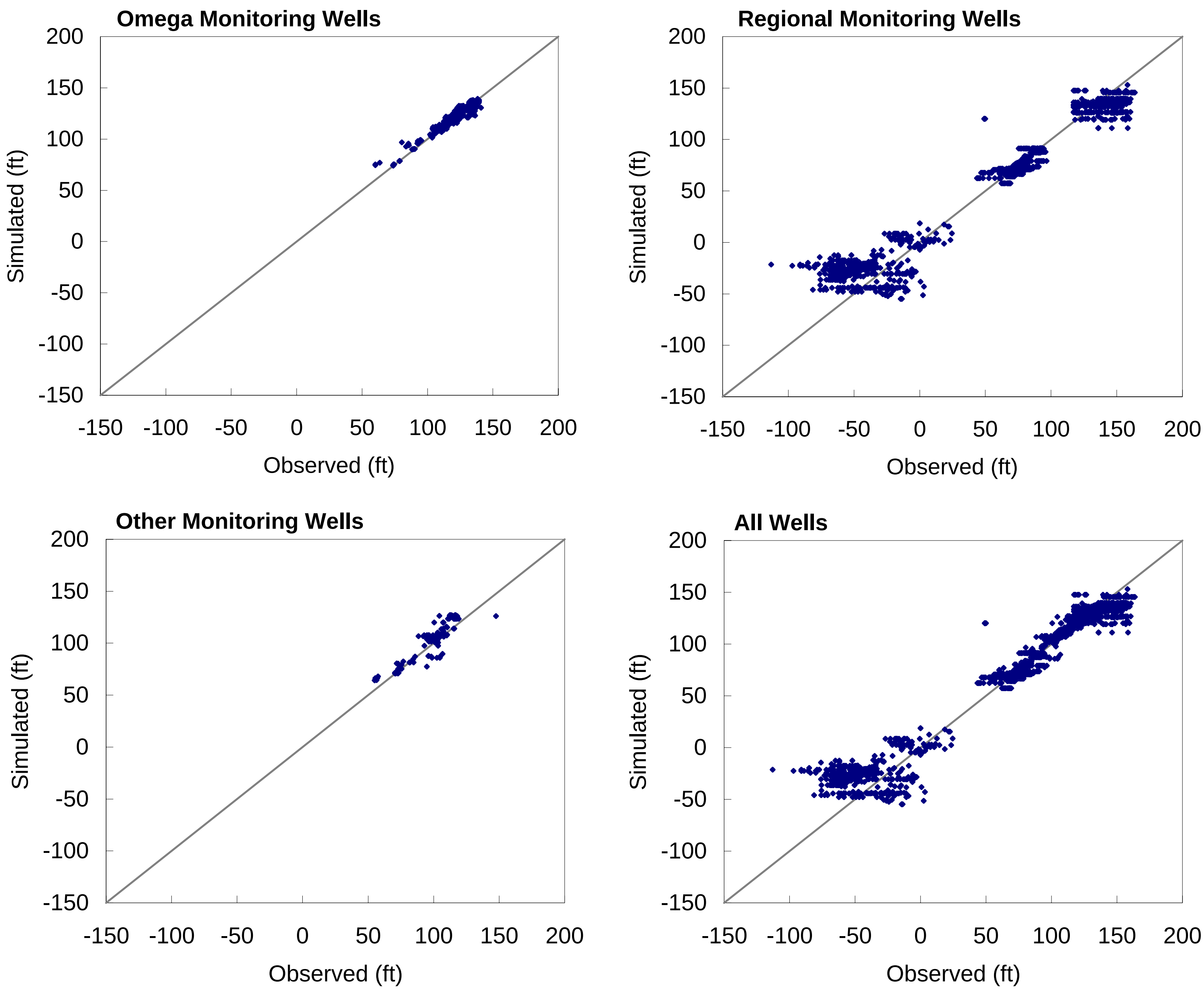
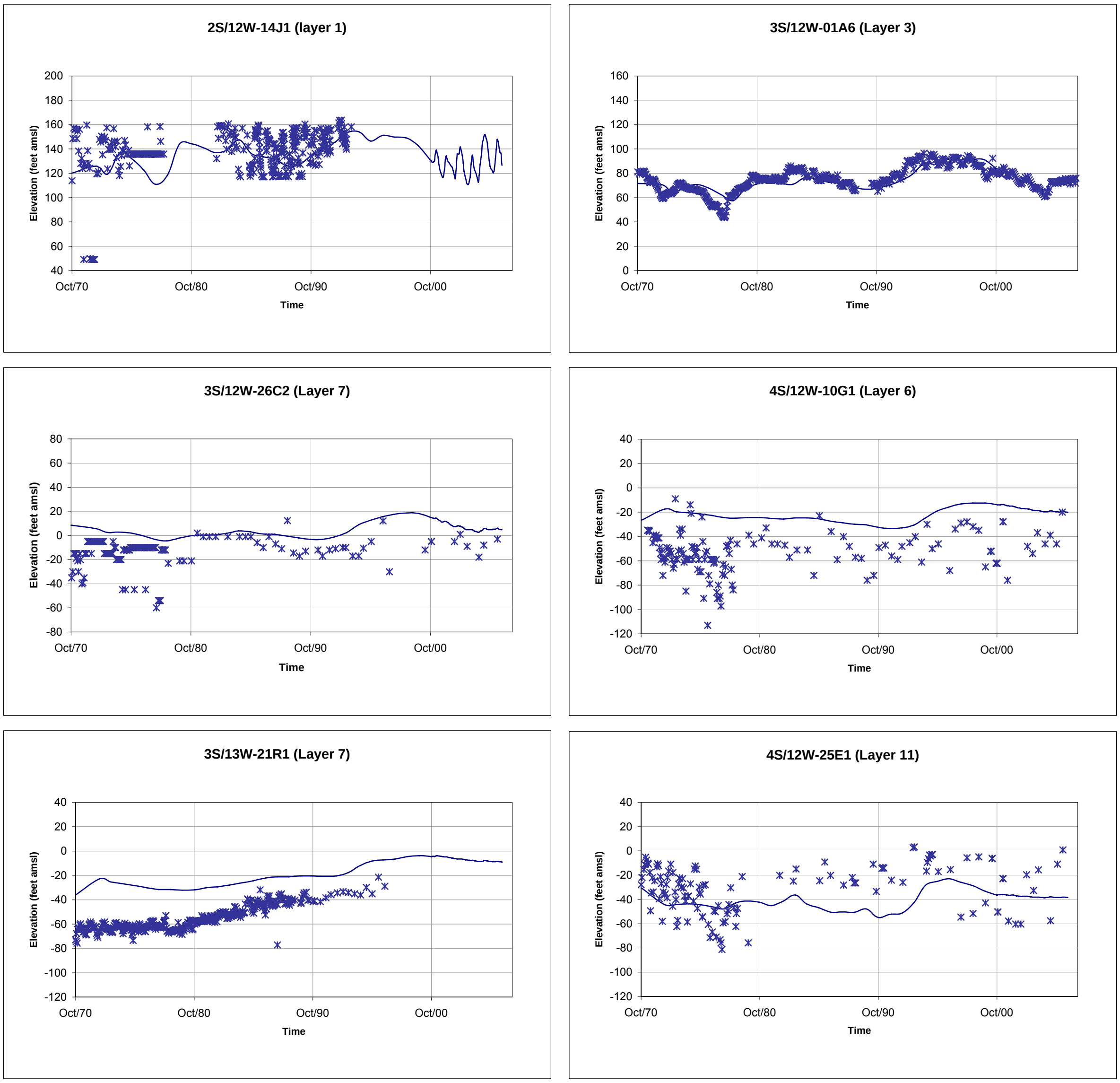


Figure K-11. Scatter Plots of Simulated and Observed Water Levels



Simulated Water level
Δ, +, ○, ж Observed Water Level

Figure K-12

Simulated and Observed Hydrographs

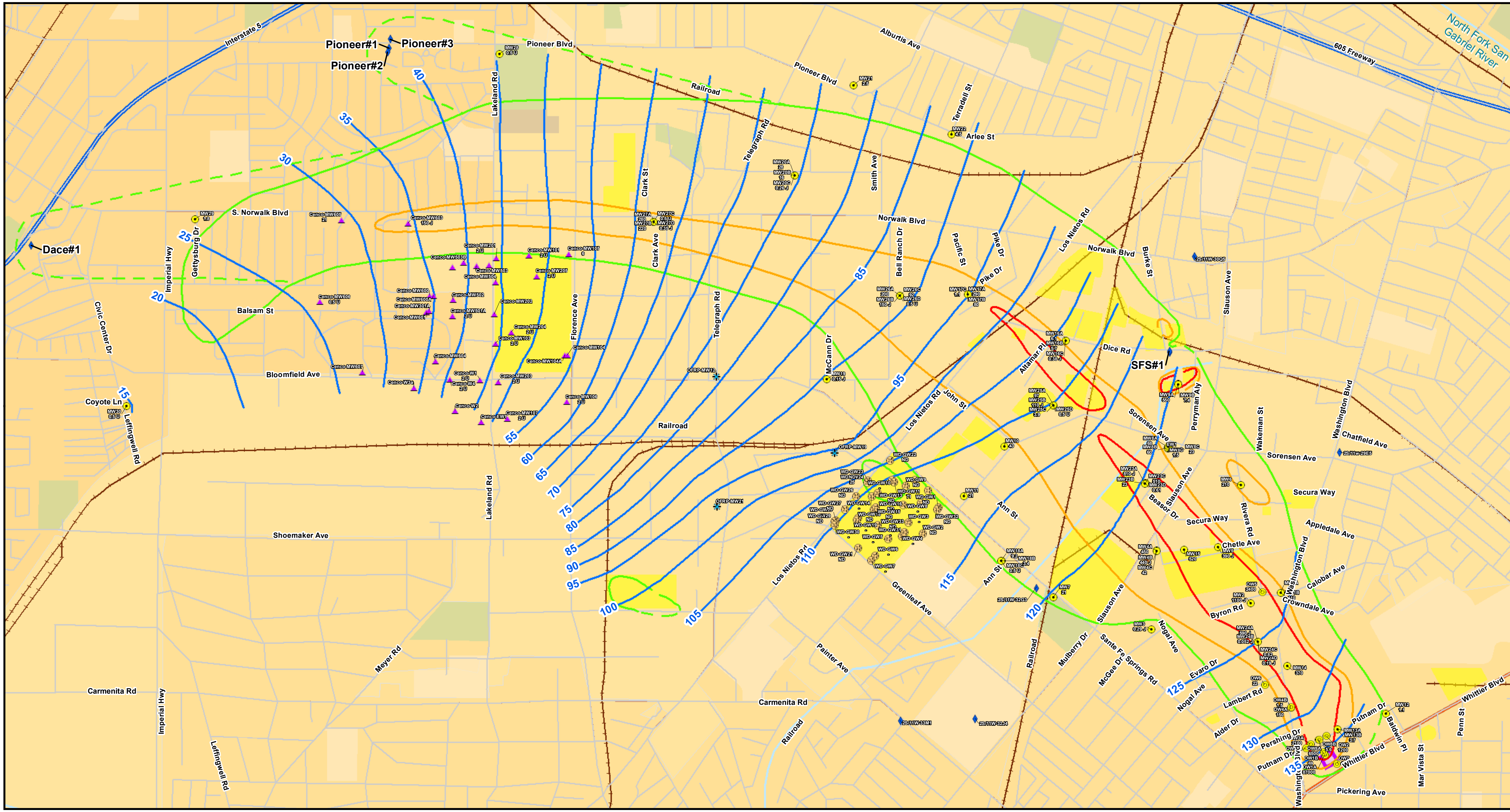
Regional Monitoring

WorleyParsons

resources & energy

ATTACHMENT B

CITED FIGURES, FS REPORT



Legend

- EPA Monitoring Well (July 2007)
- Omega Potentially Responsible Parties Organized Group (OPOG) Monitoring Well (August 2007)
- Oil Field Reclamation Project (OFRP) Well
- Waste Disposal, Inc. (WDI) Well (4th Quarter, 2002)
- Active Production Well (Locations shown are approximate)
- CENCO Wells (August - November 2006)
- Approximate Boundary of Facilities
- Former Omega Facility

Composite PCE Plume Extent, July 2007

- 5 ug/L
- 100 ug/L
- 500 ug/L
- Potential deep (about 200 feet below ground surface) PCE extent
- Water Level Contours 2007

N

0 1,600 3,200 Feet

Notes: 1) J - Estimated Value upper level of instrument calibration range. 2) U - Non-Detect 3) E - Estimated value as the concentration exceen upper level of instrument calibration range. 4) NS - Not Sampled

\\GALT\PROJ\OMEGA\2010\MAPFILES\11X17_PCE_V2.MXD DDODS

Figure 1-4
Composite PCE Distribution
Omega OU2 Feasibility Study

CH2MHILL

Date: May 5, 2010

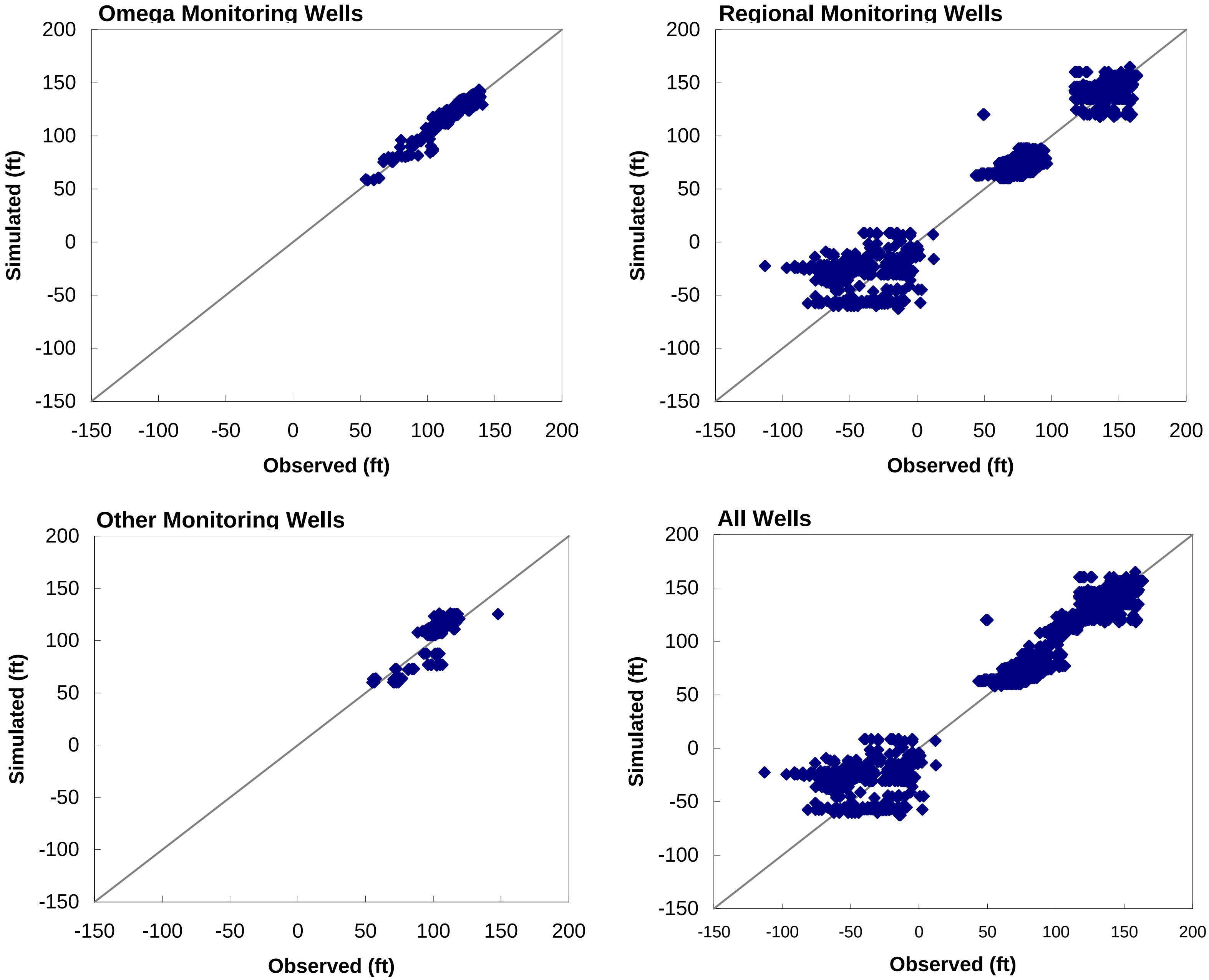


Figure A-10

Scatter Plots of Simulated and Measured Water Levels, Transient Model Simulation

Omega OU2 Feasibility Study

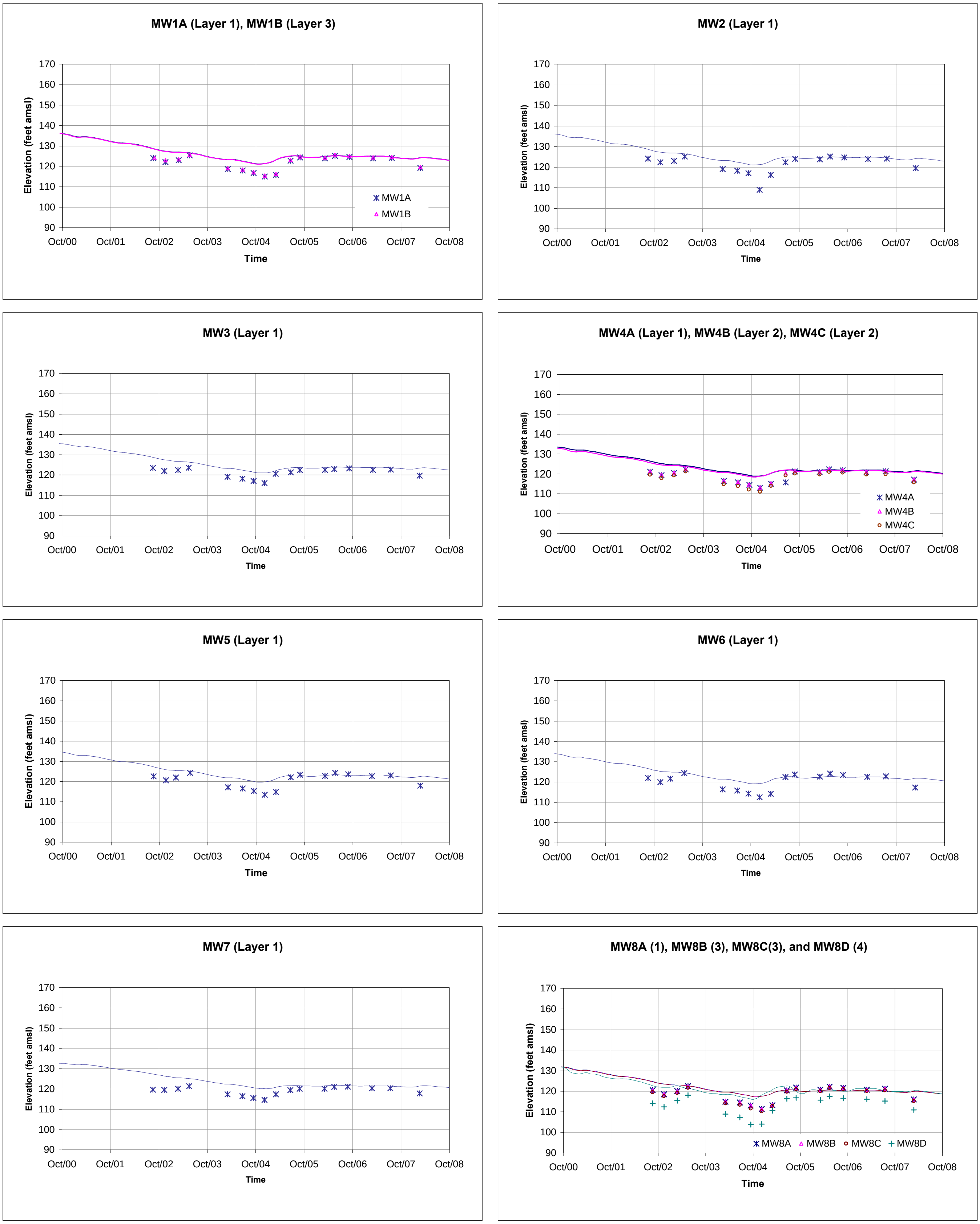


Figure A-11

Hydrographs - Simulated vs Observed

Omega OU2 Feasibility Study

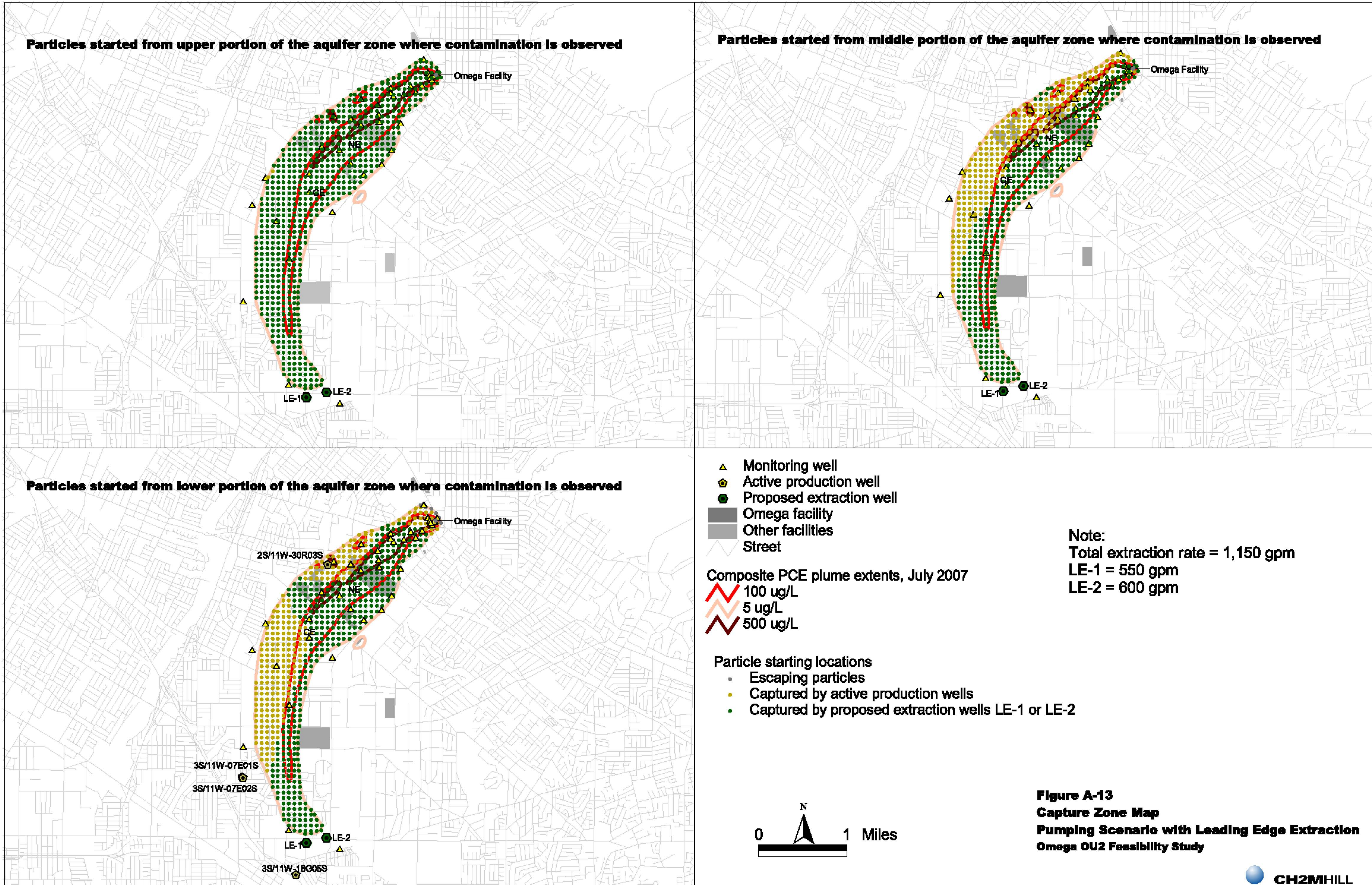


Figure A-13
Capture Zone Map
Pumping Scenario with Leading Edge Extraction
Omega OU2 Feasibility Study

CH2MHILL

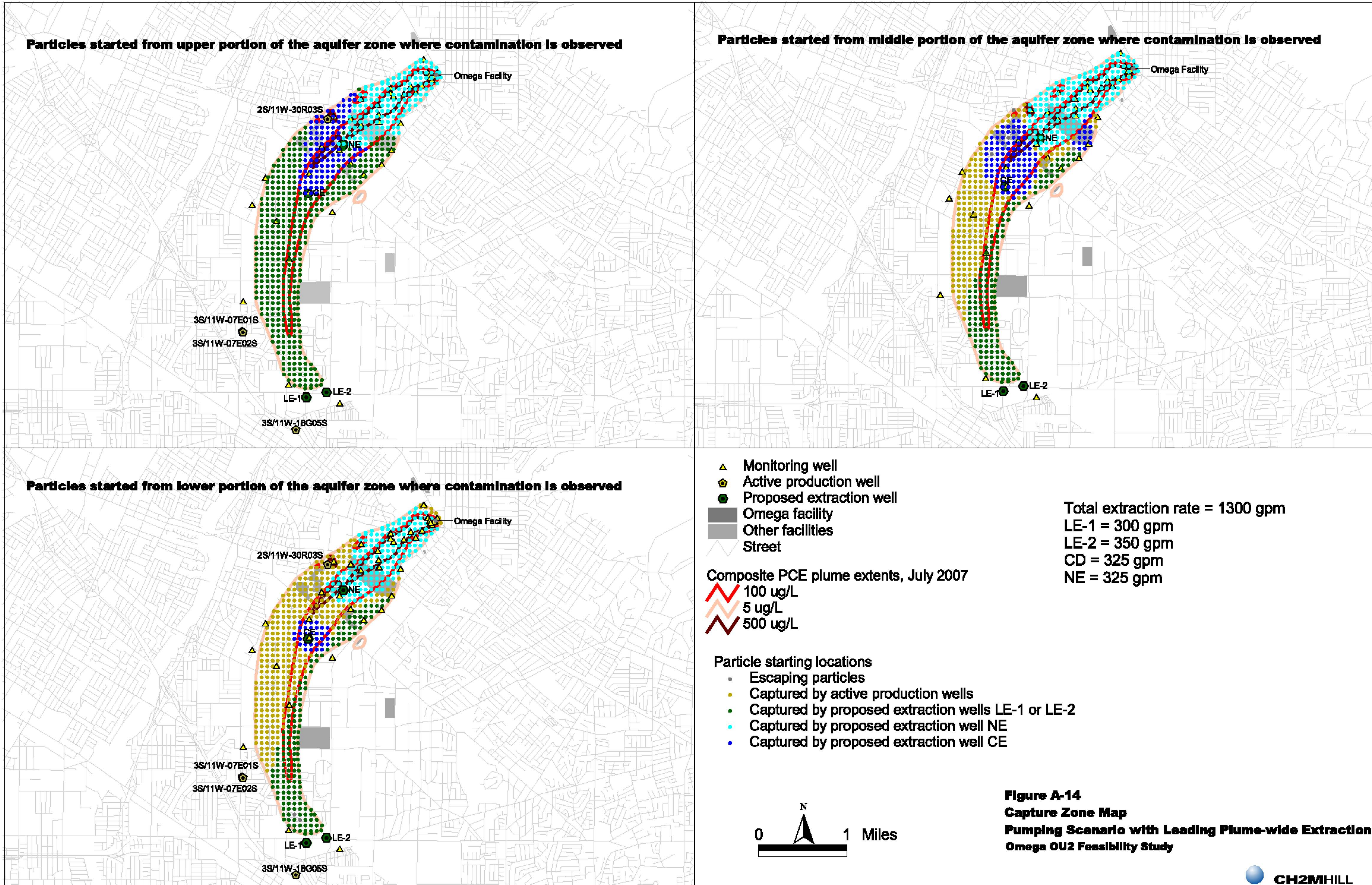


Figure A-14
Capture Zone Map
Pumping Scenario with Leading Plume-wide Extraction
Omega OU2 Feasibility Study

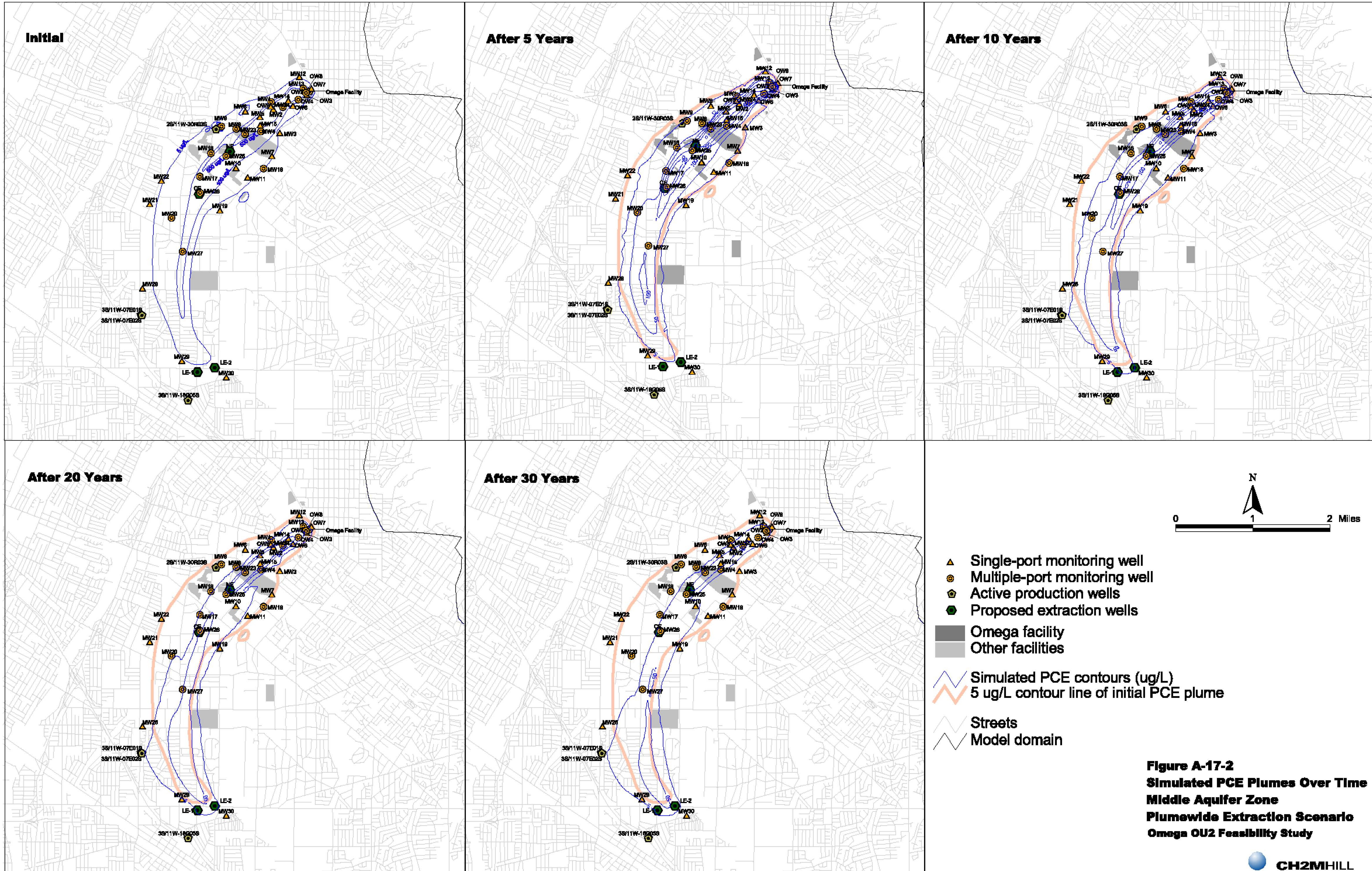


Figure A-17-2
Simulated PCE Plumes Over Time
Middle Aquifer Zone
Plumewide Extraction Scenario
Omega OU2 Feasibility Study

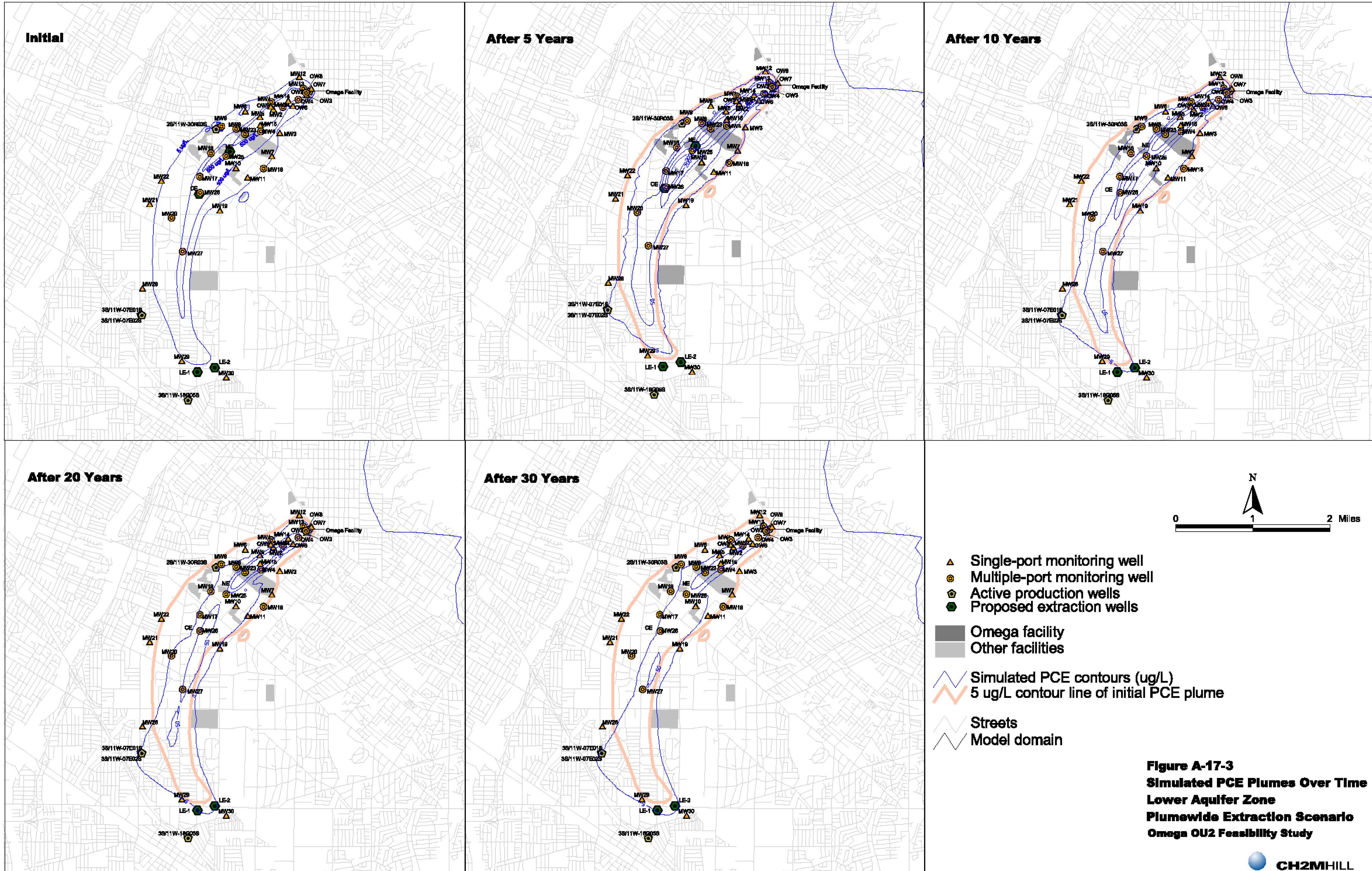


Figure A-17-3
Simulated PCE Plumes Over Time
Lower Aquifer Zone
Plumewide Extraction Scenario
Omega OU2 Feasibility Study